I. C. 6991

February 1938

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

GOLD MINING AND MILLING IN THE WICKENBURG AREA, MARICOPA AND YAVAPAI COUNTIES, ARIZ.

BY

O. H. METZGER

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By O. H. Metzger[2]

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[1] The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 6991."

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FOREWORD

This is one of a series of circulars dealing with mining and milling operations in different mining districts in the Western States. Data on operating costs, grades of ore treated, wage scales, haulage rates, and other information on mining properties are obtained from the operators and other local sources during the course of field inspections. They are believed to be substantially correct as to conditions at the time the properties were visited but may not be in accord with facts established by later developments.

Chas. F. Jackson,
Chief Engineer,
Mining Division.

INTRODUCTION

This is one of a series of papers being published by the Bureau of Mines on mining areas and districts in the Western States. It describes mining and milling practices in the vicinity of Wickenburg in Maricopa and Yavapai Counties, Ariz.

ACKNOWLEDGMENTS

The author acknowledges the aid and cooperation of the operators of the mines visited. Reports of geologists and engineers who previously visited the area were drawn upon freely. Individual acknowledgments are made in the text.

LOCATION

The principal districts in this area are the Weaver and Martinez districts in the southern part of Yavapai County, the Eureka district in about the west central part of Yavapai County, and the Vulture and Big Horn districts in the northern part of Maricopa County. Figure 1 shows the location of the mines, towns, railroads, principal highways, and streams in the area and surrounding territory.

The principal towns in the area are Wickenburg, population 734 (1930), Congress Junction, population 100 to 150 (1930), and Hillside, 250 to 300 (1930).

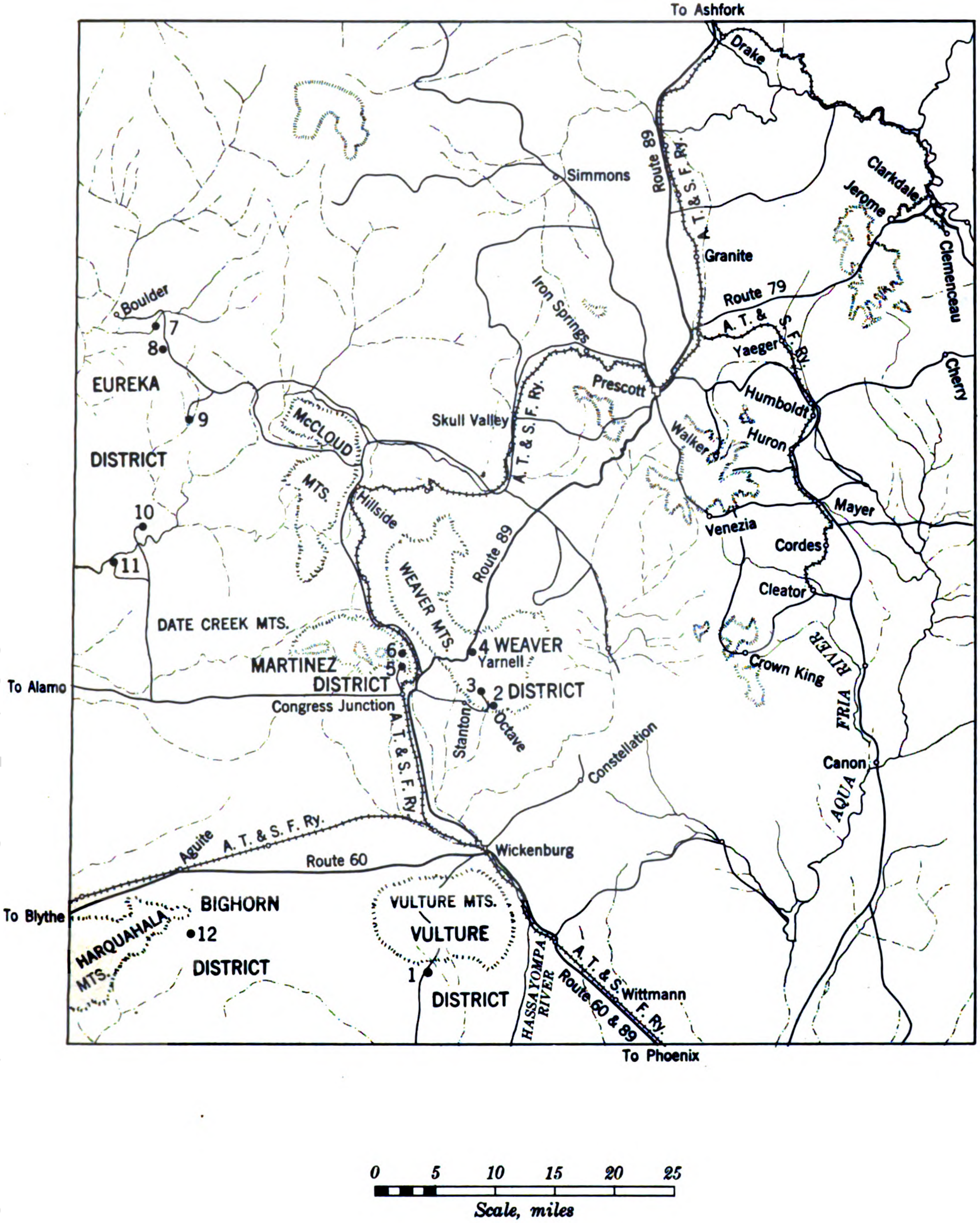

Figure 1.—Map of Wickenburg area and surronding territory. Mines: 1, Vulture; 2, Octave; 3, Johnson; 4, Yarnell; 5, Congress; 6, Reese; 7, Hillside; 8, Bagdad; 9, Comstock Dexter; 10, Oro Bueno; 11, Arizona Homestake; 12, Pump.

FACILITIES

Railroads

The area is served by two branches of the Atchison, Topeka, and Santa Fe Railroad. The main branch runs south from Ash Fork on the main line in northern Arizona to Phoenix, and the other from Cadiz, Calif., on the main line through Parker to the Ash Fork branch. Wickenburg is about 5 miles east of the Junction of the two branches; Congress Junction is about 15 miles and Hillside about 30 miles north of Wickenburg on the Ash Fork branch. Nearly all rail shipments from the area are handled at these three stations. A few shipments from the Big Horn district and the western part of the Vulture district are handled at Aguila on the Parker branch.

Considerable crude ore from all of the districts is shipped directly to the smelters, mostly to the Magma smelter at Superior, Ariz. Most concentrate shipments are sent to the El Paso plant of the American Smelting and Refining Co. The Wickenburg Ore Market at Wickenburg serves as an outlet for shipments of less than carload lots of both crude ore and concentrates.

The following tables show the freight rates from the three principal loading stations in the area to the most conveniently located smelters.

Freight rates from Hillside, Congress Junction, or Wickenburg to American Smelting & Refining Co., El Paso, Tex. (Rates are the same from all three points.)

Metal value ($) ore	80,000-lb. minimum car	60,000-lb. minimum car	40,000-lb. minimum car
Up to 15	$4.00	—	—
15 to 20	4.25	$4.50	—
20 to 30	4.50	4.75	$4.75
30 to 40	4.75	5.15	5.15
40 to 50	5.00	5.65	5.65
50 to 60	5.50	6.20	6.20
60 to 70	6.00	6.90	6.90
70 to 80	6.50	6.75	7.85
80 to 90	7.00	7.85	7.85
90 to 100	7.50	7.85	7.85
100 to 150	8.25	8.65	8.65
150 to 200	9.00	9.42	9.42

Hillside to El Paso - 525 miles.
Congress Junction to El Paso - 503 miles.
Wickenburg to El Paso - 487 miles.

Freight rates from Wickenburg, Congress Junction, and Hillside to Phelps Dodge (United Verde) smelter, Clarkdale, Ariz.

Rate: 60,000-pound minimum cars

Metal value ($) ore	From Wickenburg	From Congress Junction	From Hillside
Up to 15	$1.90	$1.90	$1.90
15 to 25	2.50	2.40	2.40
25 to 35	3.10	2.80	2.80
35 to 50	3.80	3.40	3.40
50 to 75	4.40	4.10	4.10
75 to 100	5.40	5.40	5.40

Wickenburg to Clarkdale - 156 miles.
Congress Junction to Clarkdale - 140 miles.
Hillside to Clarkdale - 118 miles.

Freight rates from Wickenburg, Congress Junction, and Hillside to Magma smelter, Superior, Ariz., or to American Smelting and Refining Co., Hayden, Ariz.

Rate: 60,000-pound minimum cars

Metal value ($) ore	From Wickenburg	From Congress Junction	From Hillside
Up to 15	$2.40	$2.40	$2.40
15 to 20	2.50	2.50	2.50
20 to 30	2.85	2.85	2.85
30 to 40	3.25	3.25	3.25
40 to 50	3.60	3.60	3.60
50 to 60	4.00	4.10	4.10
60 to 70	4.20	4.40	4.40
70 to 80	4.80	4.80	4.80
80 to 90	5.10	5.20	5.20
90 to 100	5.10	5.30	5.50
100 to 125	5.40	5.60	5.80
125 to 150	6.00	7.40	7.60
150 to 300	7.10	7.40	7.60

Rates for 80,000-pound minimum cars are about 25 cents a ton less for ore having metal values up to $30 a ton.

Wickenburg to Superior - 124 miles.
Congress Junction to Superior - 140 miles.
Hillside to Superior - 162 miles.

Wickenburg to Hayden - 145 miles.
Congress Junction to Hayden - 161 miles.
Hillside to Hayden - 183 miles.

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Highways

Wickenburg is at the junction of the east-west highway from Phoenix and the north-south highway from Prescott. Both of these highways are paved. The Vulture district is served by a graveled road in good condition, running south from Wickenburg. There is a graveled road in good condition running north from Congress Junction through Hillside and on to Prescott. The northern part of the Eureka district is served by a road in fair condition that runs northwest from the town of Hillside. The southern part is served by a branch road running north from the highway from Congress Junction to Alamo.

Operating mines are served by branch roads from the main highways. The condition of many of these roads is rough to almost impassable, depending on the nature of the country in which they were built. The State and Counties maintain all the main highways, but many mining companies, especially in the Eureka district, have had to spend large sums on the branch roads to their properties before starting operating.

Trucking

There are a number of reliable trucking contractors in Wickenburg, Congress Junction, and Hillside. The following table shows the trucking rates and the distances from a number of the mines to railroad loading stations and smelters.

From-	To-	Distance, miles	Condition of road	Per ton	Per ton mile	Remarks
Octave mine	Congress Junction.	12	Good, graded.	$2.00	$0.17	Sacked concentrates.
Meyers mine	Octave mill.	1	One end very steep, but otherwise fair.	0.50	0.50	Loaded from chute; unloading by dumping.
Arizona Homestake mine	Congress Junction.	30	10 miles bad; 20 miles fair.	4.00	0.13	Sacked concentrates.
Hillside mine	Hillside loading station.	32	Fair but very steep in places.	2.50	0.08	Sacked concentrates.
Vulture mine	United Verde extension smelter Clemenceau.	115	15 miles graded and good; 100 miles paved.	4.75	0.04	Sacked concentrates.
Reis mine	Congress Junction.	7	1 mile bad; 4 miles fair; 2 miles paved.	1.50	0.21	Shoveled both ways.
Yarnell mine	El Paso.	504	Paved.	10.00	0.02	Hauling done at convenience of trucking company; not satisfactory because of delays.

Power

The Weaver and Martinez districts are supplied with current from the Prescott substation of the Arizona Power Co. The main transmission line carries the current at 44,000 volts. At several points there are transformer stations where the voltage is stepped down to 11,000 volts for lines that go to the more isolated mines.

The following rates are available to customers using power for industrial and mining purposes. A lighting load not in excess of 5 percent of the total connected power load may be included under these rates.

Demand charge:		Per kw.
First 50 kw. of billing demand		$2.50
Next 50	do.	2.00
All over 100	do.	1.50
Energy charge:		**Per kw.-hr.**
First 100 hours use of billing demand		$.025
Next 100	do.	.02
Next 100	do.	.0125
All over 300	do.	.01

These charges are subject to increase by any additional taxes or governmental impositions that are assessed after the effective date of the rates.

When it becomes necessary to operate the Tapco steam plant of the power company the energy charges specified shall be increased 1/2 cent per 100 kw.-hr. for each 1 cent increase in the cost of fuel oil above $1.40 per barrel delivered at Tapco.

The customer shall pay in advance to the company an installation charge of $50 for installing transformers. This charge is not subject to refund.

The monthly minimum charge shall be the demand charge and in no event less than $30 a month.

In the Vulture, Big Horn, and Eureka districts, Diesel and gasoline engines are used entirely for supplying power. Fuel oil costs about 7-1/4 cents a gallon delivered at the mines in the Vulture and Big Horn districts and about 7-3/4 cents a gallon delivered at the mines in the Eureka district. Gasoline costs from 13 to 13-1/2 cents a gallon without tax delivered at the mines.

At the plant of the Hillside Mining Co., power is developed for about 1.5 cents per kw.-hr., and at the plant of the Bagdad Copper Co. for about 1.25 cents per kw.-hr.

Custom Mills and Ore Markets

Octave Mill

A limited amount of custom milling is done by the Octave Mining Co. in its flotation and cyanidation plant at Octave. The plant, however, was built primarily for milling the ore from the Octave mine. The custom ore that is handled is from small mines in the vicinity of the town of Octave.

Payments are made according to the following schedule:

Gold - Pay 90 percent of assay at $33.35 per ounce. Minimum .03 ounce.

Silver - Pay 45 percent of assay at New York price. No pay if under 1.0 ounce.

Lead - Pay 65 percent of wet assay at New York price less 1.5 cents per pound. No pay if under 2 percent.

Copper - Pay 65 percent of wet assay at electric cathode price less 5 cents per pound. No pay if under 1 percent.

The milling charge ranges from $4.50 to $6.00 per ton. The minimum charge is for ore that has a total net value of $6.00 under the above schedule. The charge is increased by 15 percent of the value of the ore in excess of the base to the maximum.

Wickenburg Ore Market

The Wickenburg Ore Market at Wickenburg accepts small shipments of less than carload lots of gold, silver, lead, and copper ores. Each customer's ore is kept in a separate bin until a satisfactory settlement is made before it is shipped to a smelter. Sampling is done by hand quartering on a steel sheet. Assaying is done by a custom assayer in Phoenix. The ore bins are at a railroad siding, and when enough ore accumulates to make up a carload lot it is mixed and shipped to a smelter. Shipments are made mostly to the American Smelting and Refining Co. plant at El Paso, Tex., and the Magma plant at Superior, Ariz.

Payments are based on the following statement, issued by the company in its open ore-buying schedule: "After proper freight and treatment charges are deducted, we arrive at the net smelter value of the ore. From this amount we deduct 10 percent as our brokerage. There is also a sampling charge of $3.25 per lot. This entitles the shipper to a control assay." A sample settlement on a small lot is as follows:

	Pounds
Net weight of lot	2,575
Moisture, 4.4 percent	113
Net dry weight	2,462

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Payments

Gold, 1.88 ounces, all at $32.20		$60.54
Silver, 0.50 ounce, no payment		
Value per ton at shipping point		60.54
Freight rate per ton	$4.50	
Smelter treatment per ton	6.00	
Total	10.50	10.50
Net smelter value per ton		50.04
Total net smelter value of 1.231 dry tons		61.60
Brokerage	$6.16	
Sampling, assaying	3.25	
Total	9.41	9.41
Due shipper		52.19

During the summer months about a carload of ore a month is received. In the winter months when working conditions are more favorable on the desert, a carload, and sometimes as much as two carloads, is received every week.

CLIMATE[3]

The climate of the area is characterized by hot summers and mild winters. The hottest months of the year are May, June, July, and August. During these months temperatures of 110° and over are common. Snowfall is uncommon below elevations of 4,500 feet. At Wickenburg, the lowest temperatures recorded over a period of 27 years were 14° and 16° during December and January. The highest temperatures recorded over the same period were 113° and 114° during June, July, and August. The mean annual temperature for this period was 64°.

The average annual precipitation at Wickenburg for a period of 20 years was 10.88 inches. The greatest rainfall is during December and January and the least during June. Summer showers are common during July and August.

In the Weaver Mountains north of Wickenburg the precipitation is greater, and high summer temperatures are less common. Snow is more common in this section. The annual precipitation is as high as 15 inches and the average annual temperature as low as 60°.

WATER SUPPLY

The area is drained by the Hassayampa and the Santa Maria Rivers, both of which become nearly dry during the dry seasons. Some of the mines of the Eureka district utilize water from the Santa Maria River for milling purposes. Subsurface water in dry stream beds is obtained by sinking shafts in the solid rock near the banks of the streams and tunneling out under the quick sands. Water from the Hassayampa River is utilized to some extent for irrigation near Wickenburg, and to a less extent for mining.

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[3] Smith, H. V., The climate of Arizona: University of Arizona Agricultural Experiment Station Bull. 130, 1930.

The Bagdad and Hillside mines in the Eureka district make enough water for present milling purposes without reclaiming any. Most of the mines in the Vulture, Big Horn, and Weaver districts depend on wells and mine water for milling. The Octave mine, in the foothills of the Weaver district, gets its water from a spring 7 miles from the property.

In the Vulture and the Big Horn districts, south of Wickenburg, the water table is from 500 to 700 feet from the surface. In the Weaver Mountains the Yarnell Mining Co. developed a sufficient water supply from two drilled wells, 62 and 87 feet deep, but in most sections of the Weaver district the water table is deeper.

Eight-inch wells can be drilled by contract for $2.50 a foot for the first 100 feet. The price increases by increments of 50 cents per foot for each 100 feet in excess of the first 100 feet. The contractor sets the casing, if it is necessary, but the owner must buy the casing and deliver it at the well. The cost of 8-inch casing is about $1.50 a foot.

WEAVER AND MARTINEZ DISTRICTS

Location

The Weaver district is in southern Yavapai County, about 15 miles north of Wickenburg in the vicinity of Stanton and Octave. It includes the mines in the south foothills of the Weaver Mountains as well as those in the vicinity of Yarnell at the top of the range. The Martinez district is just west of the Weaver district in the vicinity of Congress Junction and the Date Creek Mountains. It is sometimes considered a part of the Weaver district.

Topography

The southern part of the districts is in the foothills of the Weaver and Date Creek Mountains at an elevation of about 3,800 feet. The Weaver Mountains rise abruptly to 5,500 to 6,000 feet. The Date Creek Mountains are lower.

Geology

The country rock is mostly granite and similar rocks intruded by basic dikes. The main gold-bearing veins of the district bear northeasterly and southwesterly and dip to the northwest at 20° to 30°. They consist of quartz filling in fault fissures and contain gold-bearing sulphides of lead, copper, and iron.

History and Production

The first discoveries in the Weaver district were made in about 1860, but very little work was done until after 1895. About this time a party of eight men purchased what is today known as the Octave mine and organized the Octave Gold Mining Co. The vein was mined to a depth of about 2,000 feet on the incline, the ore being treated in a 40-stamp mill equipped for amalgamation, table concentration, and cyanidation. The property was sold in 1907, and up to 1934 three companies made attempts to operate it. Late in 1934 it was acquired by the American Smelting and Refining Co., which is operating it at present. Most of the other properties in the district were opened about 1900 or a little later.

The Congress mine,[4] discovered sometime prior to 1887, was the first discovery in the Martinez district. It was operated intermittently from 1889 to 1910, during which time the net return on bullion and concentrates was over $7,500,000. Practically all of the other mines in the district were opened shortly after the Prescott-Phoenix branch of the Santa Fe Railroad was built in 1895.

The production of the Weaver district from 1908 to 1934[5] is as follows:

Year	Value	
	Lode gold	Total metals
1908.........	$158,000	$161,863
1909.........	34,112	34,438
1910.........	-	26,448
1911.........	12,236	12,844
1912.........	4,839	4,839
1913.........	-	7,506
1914.........	4,199	4,210
1915.........	-	7,168
1916.........	19,102	20,693
1917.........	-	13,375
1918.........	-	-
1919.........	1,000	1,000
1920.........	-	-
1921.........	-	-
1922.........	-	1,301
1923.........	-	-
1924.........	250	-
1925.........	-	-
1926.........	901	901
1927.........	-	-
1928.........	4,245	4,533
1929.........	72,701	77,576
1930.........	3,488	4,218
1931.........	6,860	6,958
1932.........	13,778	13,846
1933.........	12,084	12,182
1934.........	37,956[1]	38,657[1]
Total........	385,751	454,556

[1] Minerals Yearbook, Statistical Appendix, 1935, p. 226.

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[4] Wilson, Eldred D., Cunningham, J. B., Butler, G. M., Arizona Lode Gold Mines and Gold Mining: Airzona Bureau of Mines Bull. 137, Aug. 15, 1934, pp. 69-73.

[5] Elsing, Morris J., and Heineman, Robert E. S., Arizona Metals Production: Arizona Bureau of Mines Bull. 140, 1936, p. 87.

Production of the Weaver and Martinez districts, by mines, is as follows:

Weaver district:	
Octave mine, 1895-1929.......	$1,900,000
Monica mine, 1916-1917.......	30,000
Martinez district:	
Congress mine, 1887-1910.....	8,710,000
Total.............................	10,640,000

Octave Mine

Situation

The Octave mine is about 12 miles east of Congress Junction and about 3 miles southeast of the village of Stanton in the foothills of the Weaver Mountains. The mine is at Octave, which has a population of 200 to 250, a post office, and a school for 50 to 75 pupils. A fair road runs from the mine to Congress Junction, the nearest railroad station.

Water Supply

The principal water supply, consisting of 40 to 50 gallons per minute, comes from Antelope Springs about 8 miles northwest of the property. The water is piped in a 3- and 4-inch pipe line from the spring to the mine and the mill. During the dry season, or in case the pipe line from the spring breaks or freezes, an auxiliary supply of water is furnished from an old shaft. This would probably be sufficient in almost any emergency, as there are several thousand feet of old workings under water. A multistage pump operated by a 20-horsepower motor is kept at the water level, 330 feet vertically below the collar.

Topography and Geology

The elevation at the mine portal is about 3,400 feet. The country is rough, having been cut by deep arroyas from the Weaver Mountains, but just below the mill to the south it becomes rolling and flattens out to a fairly level plain.

The country rock, granitic in character, is locally known as granodiorite. It is rather fine-grained and probably slightly more basic than true granite. The Octave vein bears N. 70° E. and dips from 18° to 25° to the north; the width ranges from a few inches to 6 feet. The vein is made up of two distinct kinds of quartz, a white and a blue variety, probably representing two distinct periods of mineralization. The white variety is the more persistent and contains nearly all the commercial ore. It has a certain amount of banding and contains galena, chalcopyrite, bornite, pyrite, and gold in appreciable quantities. The blue variety is only slightly mineralized. In places, however, it may be mineralized enough to pay for mining and milling. It occurs above or below the white quartz and generally must be broken with it.

The walls of the vein are strong and hold up well. After a section of the vein has been mined out, the hanging wall can be held up almost indefinitely with a few stulls.

The vein is cut by two basic dikes. The smaller of the two is from 4 to 6 feet wide and does not seem to affect the vein in any way. It bears about N. 40° W., dips 75° to 80° to the southwest, and is 620 feet east of the main shaft on the main haulage level. The other, from 6 to 15 feet wide, bears N. 52° W., dips nearly vertical, and is about 950 feet east of the main shaft on the main haulage level. Severe faulting seems to have taken place along the plane of the latter, either before or after it was formed, and no commercial ore, or even a definite vein, has been encountered beyond it.

Development

The mine has been developed extensively through two shafts. The west end of the mine is completely worked out; it is developed through no. 3 shaft, which is 1,800 feet deep on the dip of the vein, with levels at about 100-foot intervals. The lower levels of this section of the mine are under water and the extent of development is not definitely known. It has been estimated, however, that the total drifting and crosscutting exceeds 150,000 feet.

The east end of the mine (fig. 2) is developed through the Joker shaft, 1,250 feet deep on the dip of the vein, with levels at about 100-foot intervals. There are several thousand feet of drifts and crosscuts, and several levels are connected with the workings of the west end of the mine for ventilation. The drifting on the 1,250 level and most of that on the 1,150 level was done in 1936.

Mining Methods

Prospecting.- Prospecting is done by drifting along the vein. In places where the vein is pinched the walls are followed. Considerable diamond drilling was done on the 800 level in 1934. Six holes at intervals of 100 to 150 feet and from 50 to 100 feet deep were drilled into the hanging wall upward at an angle of about 60° from horizontal. One of these cut what appeared to be commercial ore about 1 foot thick. The other holes were blanks. Drilling was done by a contractor, and the average price paid was $2.50 a foot.

Drifting.- If the vein is over 2-1/2 feet thick the drift is located so that the hanging wall of the vein will form the top of the drift (fig. 3a). The vein material is first slabbed out for a width of 10 to 12 feet, as shown. The purpose is to keep ore and waste separate and obviate sorting. After the ore is broken and cleaned up, the waste of the footwall is drilled and shot to form the bottom of the drift. The drift is kept from 10 to 12 feet wide so that it can be double tracked. The average advance in these drifts is from 3-1/2 to 4 feet per round, and two shifts are required to complete a cycle.

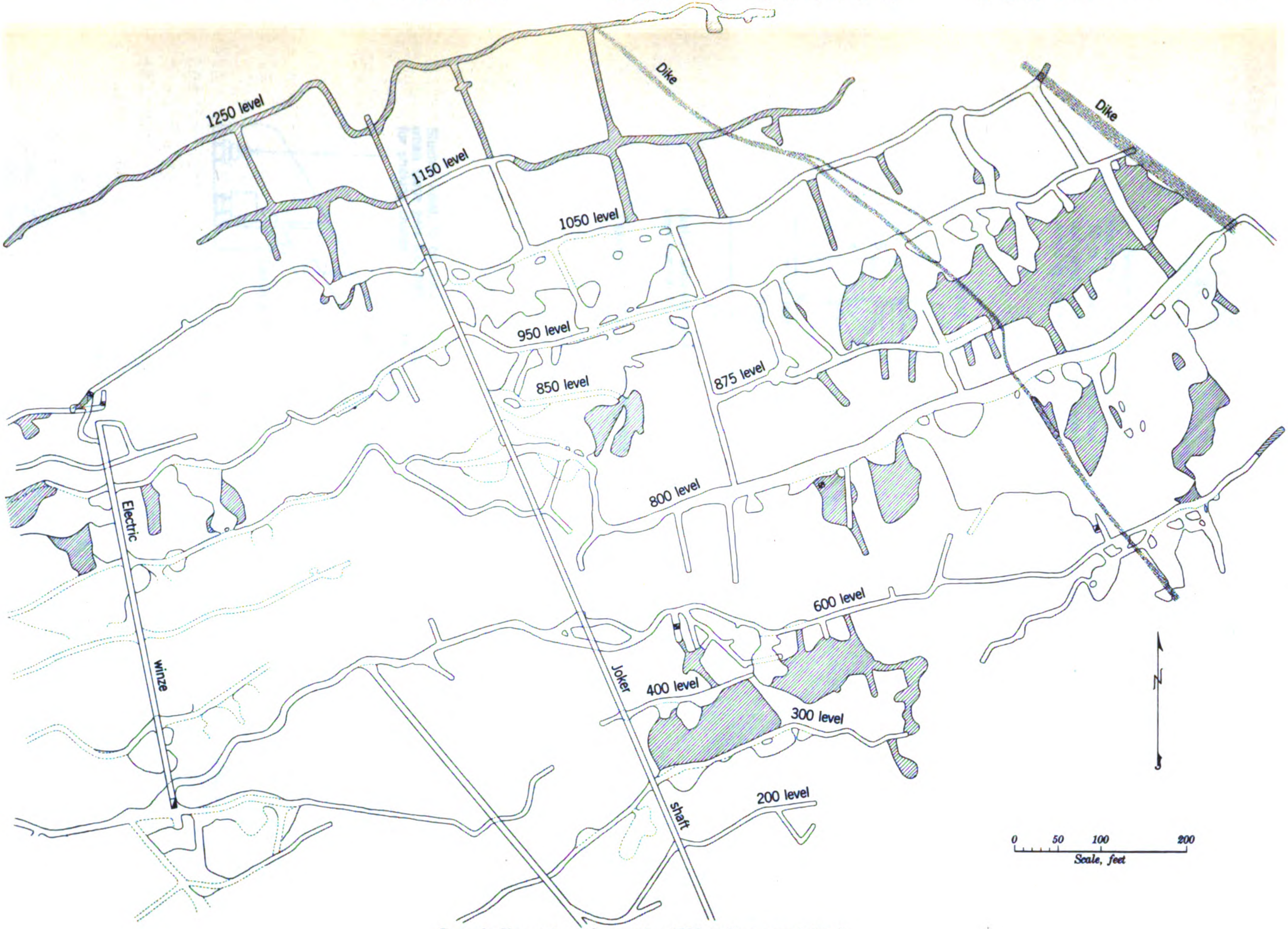

Figure 2.–Plan, east end Octave mine, 1936 workings cross hatched.

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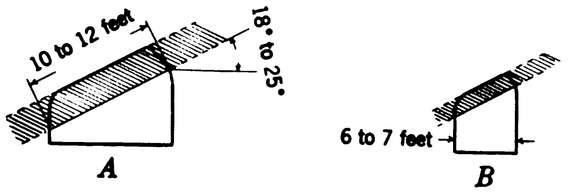
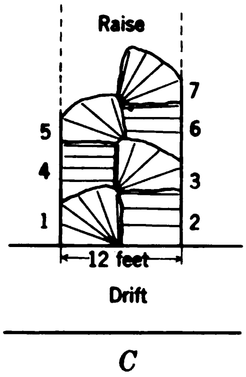


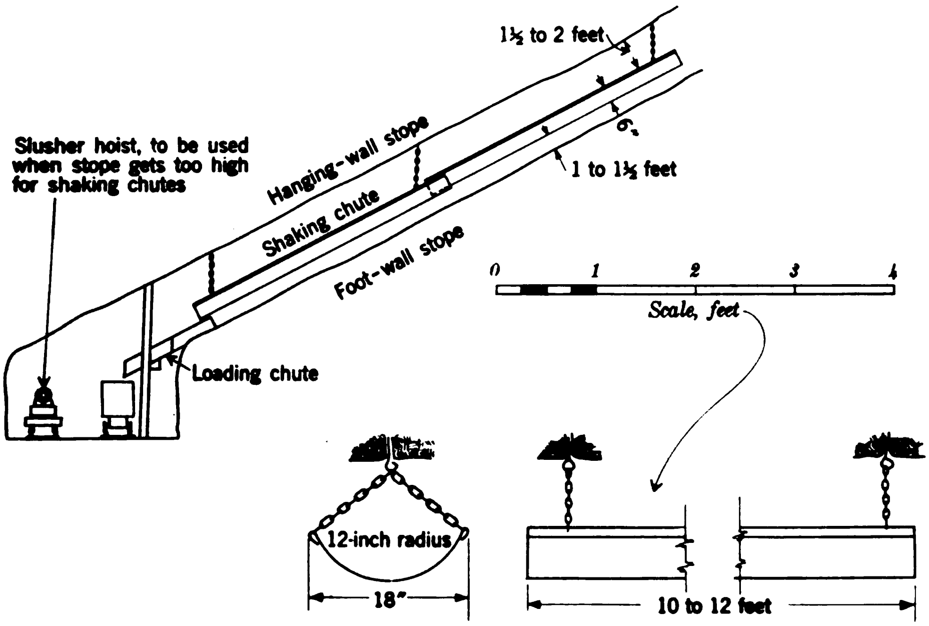
Section of drift where ore is more than 2½ feet thick. From 10 to 12 feet of ore is slabbed out and shoveled up before waste is broken

Section of drift where ore is less than 2½ feet thick. The whole round is drilled, but waste is shot first and cleaned up before the ore is shot



Sketch showing raise rounds, view normal to plane of vein

Figure 3.—Sketch showing methods of drifting and raising, Octave mine.



DETAILS OF SHAKING CHUTE

Figure 4.—Shaking chutes and loading chute.

If the vein is less than 2-1/2 feet thick (fig. 3b), drifts are run from 6 to 7 feet wide and about 7 feet high; the whole face of the drift is drilled, but only the waste under the ore is shot. The mucker on the following shift cleans up the waste and loads and shoots the holes in the ore. The machine man and helper come in on the next shift and clean up the ore (generally not more than three or four cars), set up and drill the whole face, and shoot only the waste. The helper works with the machine man until the mucking is finished and the machine is set up, and then the machine man works alone. The mucker works in some other place in the mine for the rest of the shift. The average advance per round in drifts of this kind is about 4 feet. From 65 to 75 sticks of powder are required to break a round of 12 to 18 holes. Sixty percent powder is used in the cut holes and 45 percent in the others. All holes are stemmed with paper cartridges filled with mill tailings. The paper cartridges are furnished by the powder company for about $3.50 a thousand.

In November 1936 drifting was in progress in the east end of the 600- and the 1,150-foot levels and in the east and west ends of the 1,250-foot level.

Raising.- Raising on the vein of 20° to 30° dip is done with a mounted machine, generally a jackhammer weighing 87 pounds unmounted or 117 pounds with the shell. A raise is carried 12 feet long by the thickness of the vein when possible. If the vein is not thick enough to provide working room, some waste, either from the hanging wall or the footwall, but generally from the hanging wall, must be broken with the ore. Ordinary raise rounds are not used; a raise is advanced by a system of slabbing rounds (fig. 3c). The average advance is about 2-1/2 feet per round.

For the first 15 or 20 feet, the ore is worked down by hand to a loading chute at the level. Loading chutes consist of only a bottom, side boards, and wing boards. This same type of chute is used in the stopes.

After the raise has been advanced 20 feet or more, shaker chutes are used for running the ore from the top down to the loading chute. Shaker chutes (fig. 4) consist of a piece of sheet steel, 3/32- to 1/16-inch thick, bent into a cylindrical arc 18 inches across the top and on a 12-inch radius. A piece of strap iron 2 inches by 3/8 inch is riveted to one or both ends of the chute to provide means for attaching the chains by which the chutes are suspended from the hanging wall of the raise. Each chute section is about 12 feet long. The section used at the lower end of the raise next to the loading chute is provided with a chain at each end, by which it is suspended from plugs in the hanging wall. The other sections are provided with a chain at one end only. The upper ends are suspended and the lower ends rest upon the upper ends of the sections below and are fastened to them by track bolts that run through holes drilled for that purpose.

The chutes are filled by hand shoveling; the ore is caused to run from the top to the bottom by hand shaking. They are used successfully for transferring ore down raises up to 100 feet long, from 10 to 12 sections being used. They are also satisfactory in small irregular stopes where mechanical slushing cannot be used successfully.

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In November 1936, raising was in progress above the 600-, 1,150-, and 1,250-foot levels.

Stoping.- The distance between levels is about 100 feet along the dip of the vein. This distance, however, varies greatly, due to variation in dip along the strike. In one place in the mine, where the vein flattens out to about 15°, the distance between levels is 150 feet. Before mining is started, raises are run through from level to level at 100-foot intervals. The interval between raises constitutes a stoping section. In November 1936, four stopes were in operation - one on the east side and one on the west side of the shaft on the 950-foot level, one on the east side of the shaft on the 600 level, and one on the east side of the shaft on the 800 level.

Two systems of mining have been used since the mine opened in 1935. The first one is now being supplanted wherever possible by a more recent development. Both methods depend upon the use of the mechanical slusher to move the ore from the top of a stope to the loading chutes on the haulage level.

In the first system (fig. 5) stoping starts from the back of the haulage drift. The ore is shot down on the floor of the drift and shoveled by hand into cars until the stope is far enough advanced to install loading chutes. These are placed at 35-foot centers. As the ore is broken from the top of the stope, it is slushed into the loading chutes with a mechanical slusher and loaded directly into one-ton mine cars. Shaking chutes are sometimes used until the back of the stope is advanced from 25 to 35 feet from the drift.

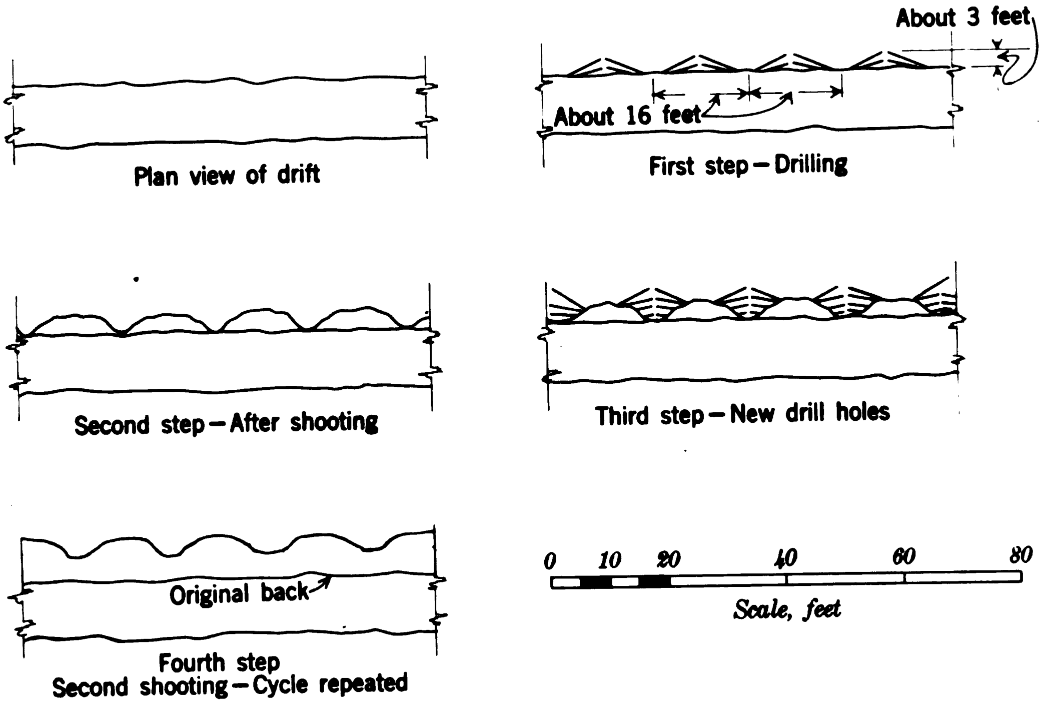
Large pieces of waste that are broken with the ore are sorted out and cast aside in the mined-out portion of the stope. As the stope is advanced, stulls are placed at 8- to 12-foot centers, depending on the nature of the hanging wall.

In the more recently developed method, the raises are run through from level to level the same as for the older method, but breaking starts from the top of the raises instead of from the back of the haulage drift (fig. 6). Rounds are drilled downward at an angle of 45° to 60° with the raise. The broken lines in the figure show the condition of the stope when stoping first starts, and the full lines show the condition after stoping has progressed for some time.

In order to facilitate slushing, the stulls for supporting the hanging wall are kept as nearly as possible in a line approximately parallel with the face of the stope.

This method was found preferable to the first method because it is safer and requires less timber replacement and, also, unmounted drills can be used.

Because of the cramped conditions in which the men must work in the stopes it is necessary to use as light a machine for drilling as possible. The machine that has been adopted is a jackhammer that weighs 87 pounds



Plan view of drift

First step—Drilling

Second step—After shooting

Third step—New drill holes

Original back

Fourth step
Second shooting—Cycle repeated

Figure 5.—Method of back stoping, plan views, Octave mine.

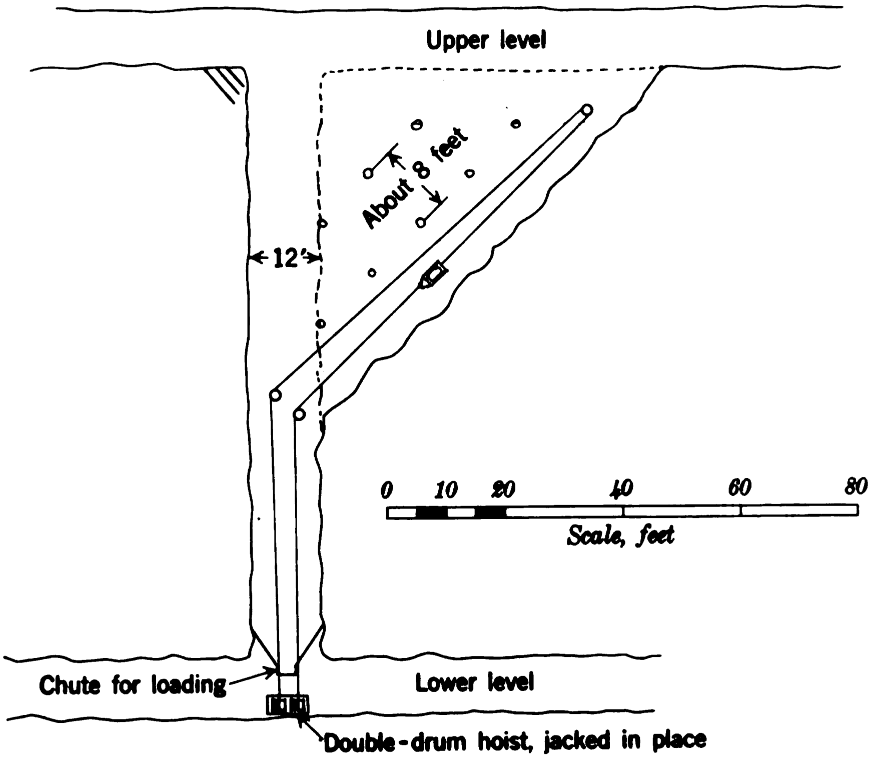


Figure 6.—No. 2 method of underhand stoping, plan view, Octave mine.

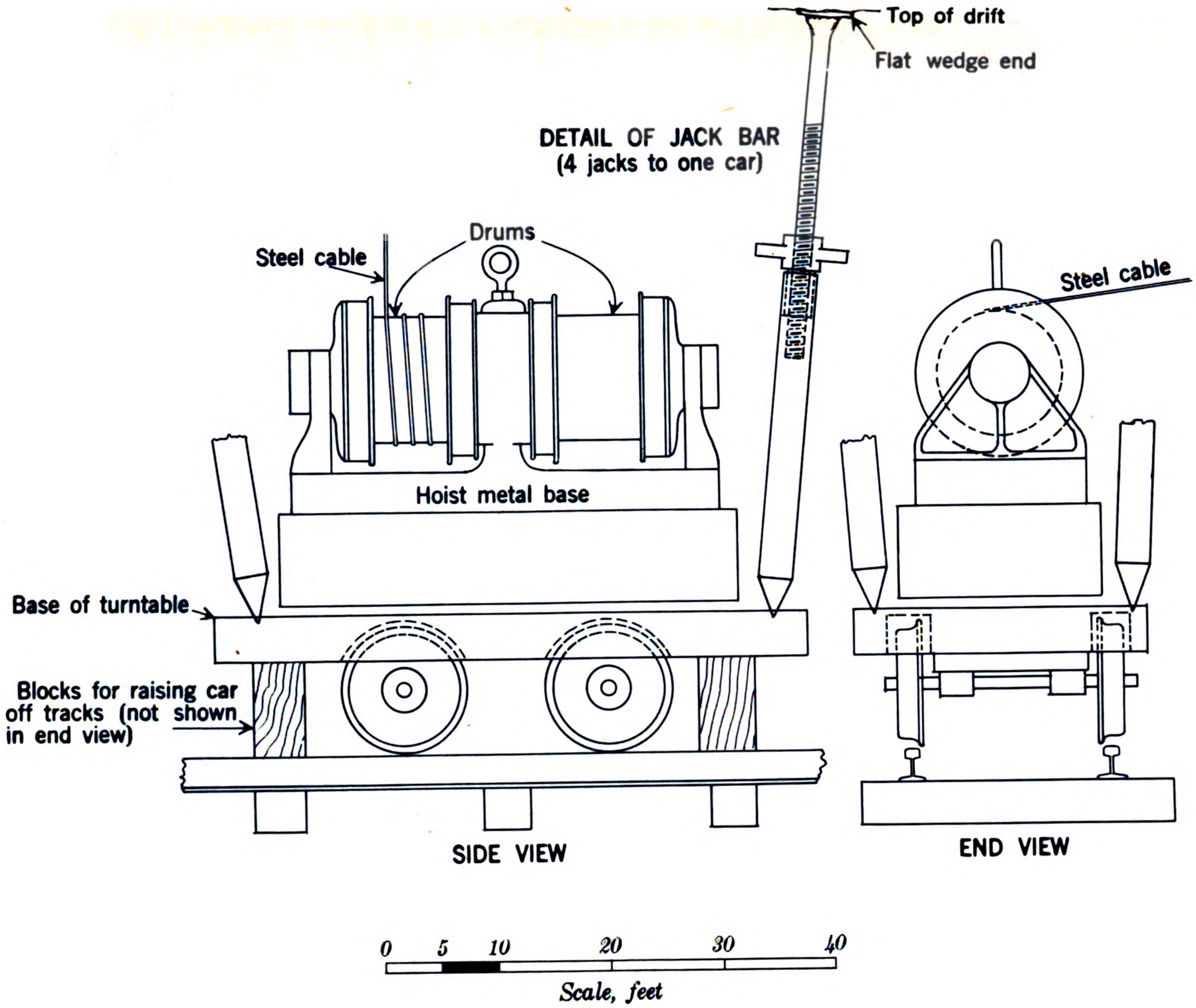


Figure 7.—Details of hoist car and apparatus for jacking in place.

unmounted and 117 pounds with the shell. When back-stoping or drilling up-holes, the machines are mounted. When drilling down-holes, they are used unmounted. A common practice in stopes where mostly down-holes are drilled is to lay the machine on a plank and put on pressure with the feet. The drills must be mounted to cut out around pillars of waste that are encountered occasionally. Most of the holes are drilled near the footwall of the stope. The purpose of this practice is to avoid shattering the hanging wall. One-inch round steel with 12-inch changes and machine-sharpened bits is used in all drills.

The management is making an endeavor to standardize on a machine for all purposes, slightly lighter than the drifter used in the drifts, but sturdier than the jackhammers. At present there is no machine on the market that fulfills all the requirements, but a number of manufacturers have promised their cooperation in developing such a drill.

It has been found prudent to observe a considerable amount of caution in blasting. The priming cartridge is placed in the middle of the charge, and wooden spacers 1 inch square and 1 inch long are placed between the cartridges. This has the effect of diluting the charge and also distributes it over a greater length of the hole. Forty-five percent gell-EX is used in all of the stopes.

Slushing.- The slusher is operated by a small double drum hoist mounted on a turntable on the deck of a car truck. The whole unit runs on a track in the hanging wall side of the drift and can be moved from one chute to the next without interfering with tramming or other operations. When the hoist is in use for slushing, the car truck is placed on blocking just high enough so that the wheels of the truck will not rest on the car track. The truck is then jacked down from the back of the drift by four jack screws (fig. 7).

Two electric hoists and an air hoist are in use. The electric hoists are mounted on car trucks as described. The air hoist is mounted on skids and is taken up into the stopes and in close places where it would be impossible to take the electric hoists.

The motor and the drums of the electric hoists are mounted on the same shaft, the motor being between the drums. The hoists are provided with clutches but not brakes. The cables run from the top of each drum, so that the drums turn in opposite directions while the hoist is in operation. Three-eighths-inch, 6 by 7 cable is used, except when slushing for a distance of more than 100 feet. In such cases, 1/4-inch cable must be used in order to get enough on the drums. The hoists, as received from the manufacturers, did not have cable guards. A steel frame was welded to the frame of the hoists and cable guards for the sides, top, and bottom were attached to this frame. The side guards consist of rollers about 2 inches in diameter. The top and bottom guards are just a piece of round rod or a piece of strap iron. In most slushing operations, cable guards are essential to keep the cables from fouling the drums and the motor. The latest hoists for this purpose have guards that can be adjusted for slushing from any angle above or below and are provided with brakes as well as clutches.

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The slushers or scrapers (fig. 8) are made up at the company's shop from 1/8- or 3/16-inch sheet steel. Material from old cyanide tanks used by former operators was found to be satisfactory. The first scrapers were made by using angle irons at the corners for welding the sheet-iron pieces together. Later, it was found that a lighter scraper and one just as serviceable could be built by turning down the edge of one sheet and welding it to another. The scraper blade is manganese steel and is set at an angle of about 10° from horizontal. This has been found very satisfactory for scraping down inclines of about 30°. For scraping horizontally or a little up-grade it would have to be set at a steeper angle.

All wearing edges and points are faced with hard surfacing material by welding. Some scraper blades are refaced after they become worn, but if the wear has been too great they are discarded and replaced by new ones.

The life of a scraper depends upon the stope in which it is used. If the bottom of the stope is smooth, the scraper will last a long time; in stopes with rough bottoms, the life is relatively short. A scraper generally lasts until three or four blades have been worn out; after that it is ready for the scrap heap. The average duty of a scraper since the mine was started 2 years ago has been about 7,000 tons.

Two men are required for slushing - one for operating the hoist and one for "bulldogging" the scraper in the stope. The hoist operator gets a miner's pay and the "bulldogger" a mucker's pay.

Slushing operations become uneconomical when the material must be moved for more than 100 feet. At a number of places in the mine where the levels were more than 100 feet apart on the incline of the vein, sublevels were run in order to facilitate mining.

Tramming and hoisting.- All tramming below the main adit level is done by hand in 1-ton cars. The ore is dumped directly into a 2-ton skip and hoisted through the one-compartment shaft to an ore bin of 40-ton capacity at the main adit level. Waste is trammed and hoisted in the same manner but is deflected by a trapdoor into a waste bin of 18-ton capacity. Hoisting is done on both shifts.

Horses are used for tramming from the bins at the shaft on the main adit level to the mill and the waste dump. A horse pulls a train of 12 1-ton cars. The distance from the underground bins to the portal is 1,700 feet and from the portal to the mill bins is 2,000 feet. The waste is taken to a waste dump about the same distance from the portal as the mill bins. All tramming is done on day shift, but sometimes it is necessary to work overtime.

Labor.- The company furnishes quarters for the single men. The boarding house is run by a chain boarding house company that charges $1.50 per day for board. There are a number of houses in and near the town of Octave for family men. The school in Octave has an attendance of about 45.

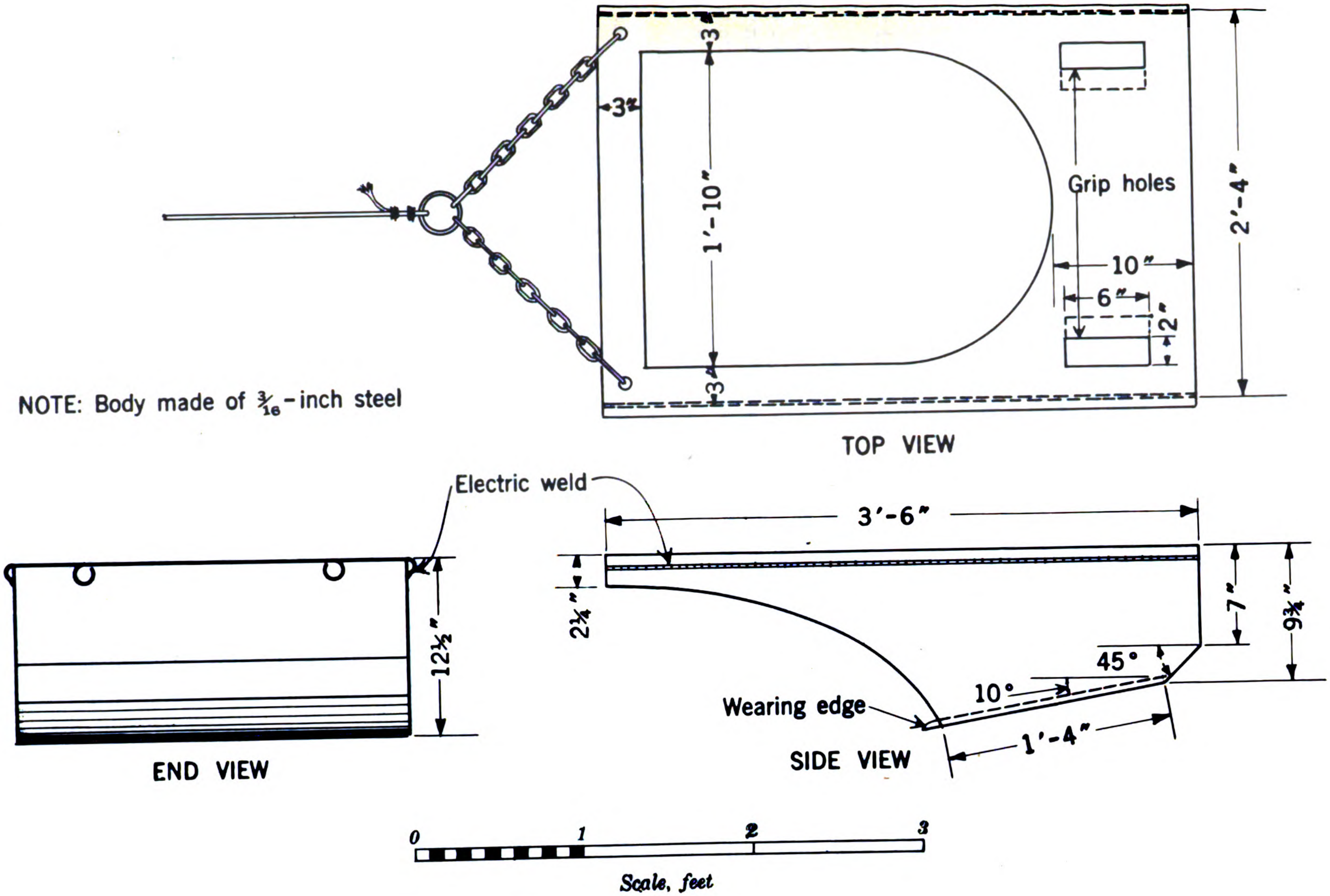

Figure 8.– Details of slusher.

In November, the mine and the blacksmith shop were changed from 7-hour to 8-hour shifts. Wages for miners were changed from 57 cents per hour to $4.50 a day, and for muckers from 50 cents per hour to $4.00 a day. In November the mine and shop payroll was as follows:

16	miners	$4.50	$72.00
20	muckers	4.00	80.00
2	timbermen	4.50	9.00
2	hoistmen	4.50	9.00
2	slushers	4.50	9.00
1	mule skinner	4.50	4.50
2	nippers	4.00	8.00
1	topman	3.50 on grizzly	3.50
2	shift bosses	5.00	10.00
48			205.00

Contracts and leases.- Contracts are given only in places where special mining problems are involved and where highly skilled labor is required.

Two mining contracts were going during November 1936. There were two miners and a mucker on one and two miners on the other. The contractors are given a flat rate of $2.50 per ton for breaking the ore, loading it in cars, and delivering it at the shaft. The company furnishes all explosives and equipment and gives the contractors a wage guaranty. The contractors make as much as $10 a day.

Leasing is done on a limited scale. In November, there was one leaser who employed 3 miners and 3 muckers. The lease is arranged on a sliding scale in such a way that the grade of ore is more important to the leaser than tonnage.

Power.- Power is purchased from the Arizona Power Co. and is taken from the 44,000-volt line that runs near the property. The voltage is stepped down to 440 volts for use in the motors and 220 and 110 volts for lighting.

The connected horsepower in the compressor house, hoist room, and shops is as follows:

Compressor	100
Do.	1/75
Carpenter shop	2
Forge	1
Machine shop	5
Do.	2
Hoist	50
Slusher	7.5
Mine waste pump	10
Total	252.5

1/ Used in emergency only.

Milling

The mill is on a hillside about 2,000 feet from the portal of the main adit haulage tunnel, with the top of the coarse-ore bins at the level of the haulage track. The building is of timber construction and was erected by former operators. Practically all of the machinery was installed by the present company. The ore is treated by flotation and cyanidation; about 80 percent of the recovery is made by flotation. The normal capacity of the plant is from 90 to 100 tons a day. In November 1936, it was operated at about 75 to 80 tons a day. About 70 tons of this was from the mine and the rest was custom ore. The flow sheet is shown in figure 9.

Crushing and grinding.- The ore is dumped on grizzlies at the top of two ore bins of 80 tons capacity each. The openings between the grizzly bars is from 5 to 6 inches. A man is kept busy at the grizzlies breaking up large pieces and helping the trammer dump the cars. No sorting is done at the grizzlies.

From the coarse-ore bin the ore runs through a 9- by 16-inch jaw crusher, where it is crushed to about 3/4-inch. From the crusher it goes on a horizontal conveyor belt to the fine-ore bin; the conveyor is 55 feet long and at an inclination of 12°. From the fine-ore bin it is fed into a 6- by 6-foot ball mill by a belt feeder about 6 feet long. The ball mill is in closed circuit with a 16-foot duplex drag classifier. Screen analysis of the classifier overflow shows that 75 percent is minus 200 mesh and none is plus 80.

The ball-mill load consists of 12,000 pounds of 4-inch steel balls. The ball consumption is about 4-1/2 pounds per ton of ore. Manganese steel liners last about 9 months.

Sampling.- Custom ore is sampled in a sampler ahead of the fine ore bin (fig. 9). Head samples for the mill are taken each hour by diverting the ball-mill feed for 15 seconds. These samples are delivered to a small bin, where they make up a composite head sample for the shift. At the end of each shift the composite sample, consisting of about 200 pounds, is run through a small crusher, which reduces it to about 1/4 mesh. It is then quartered, and the final is sent to the assay office; the reject is sent back to the fine-ore bin by means of a bucket elevator.

Concentrating.- The classifier overflow goes through six mechanically agitated flotation cells. A finished concentrate is taken from the first cell. The overflow from the second and third cells goes back to the classifier, and the overflow from the fourth, fifth, and sixth cells is returned to the third cell.

The concentrates go through a thickener and then through a 2- by 4-foot Portland-type filter. The water from the thickener and the filter is returned to the mill storage tank. After the concentrates are filtered they are spread out on a drying floor, where they are left to dry and then sacked for shipment. A shipment of 35 to 40 tons is made about once a month to the American Smelting and Refining plant at El Paso.

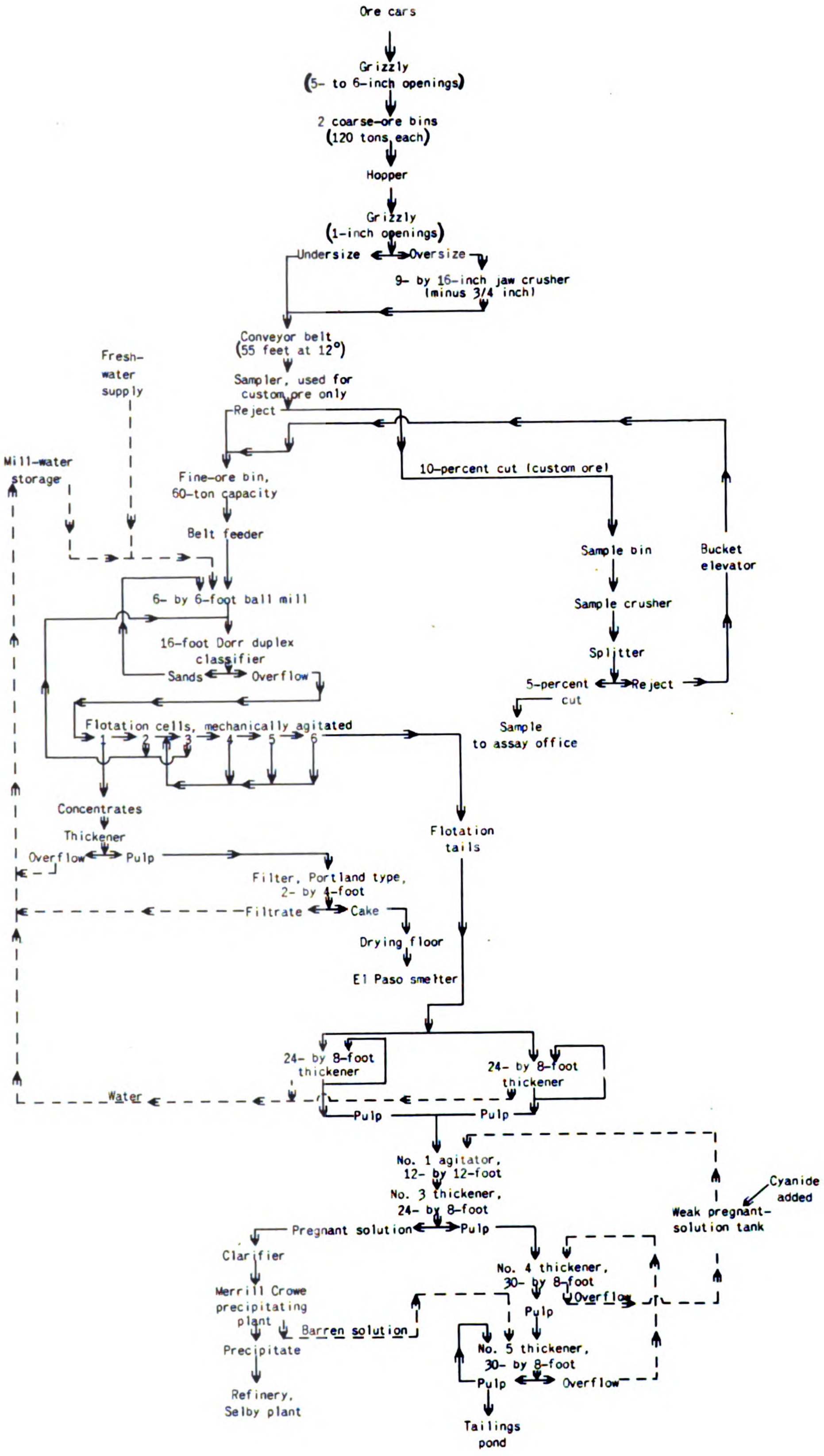
Ore cars
Grizzly (5- to 6-inch openings)
2 coarse-ore bins (120 tons each)
Hopper
Grizzly (1-inch openings)
Undersize
Oversize
9- by 16-inch jaw crusher (minus 3/4 inch)
Conveyor belt (55 feet at 12°)
Sampler, used for custom ore only
Reject
Fresh-water supply
Mill-water storage
Fine-ore bin, 60-ton capacity
Belt feeder
10-percent cut (custom ore)
Sample bin
Bucket elevator
Sample crusher
Splitter
5-percent cut
Reject
Sample to assay office
6- by 6-foot ball mill
16-foot Dorr duplex classifier
Sands
Overflow
Flotation cells, mechanically agitated
1
2
3
4
5
6
Concentrates
Thickener
Overflow
Pulp
Filter, Portland type, 2- by 4-foot
Filtrate
Cake
Drying floor
El Paso smelter
Flotation tails
24- by 8-foot thickener
24- by 8-foot thickener
Water
Pulp
Pulp
No. 1 agitator, 12- by 12-foot
No. 3 thickener, 24- by 8-foot
Cyanide added
Weak pregnant-solution tank
Pregnant solution
Pulp
Clarifier
No. 4 thickener, 30- by 8-foot
Overflow
Merrill Crowe precipitating plant
Barren solution
Pulp
Precipitate
No. 5 thickener, 30- by 8-foot
Pulp
Overflow
Refinery, Selby plant
Tailings pond

Figure 9.- Flow sheet, Octave mill (capacity, 80 to 90 tons).

The ratio of concentration is from 35 to 45 to 1. Typical head, tail, and concentrate assays from the flotation circuit are as follows:

Flotation heads	0.3 gold ounce per ton.
Flotation concentrates	12.5 gold ounces per ton. 15 silver ounces per ton.
Flotation tails	0.05 gold ounce per ton.

There is enough lead and copper in the concentrate to avoid a deficiency penalty at the smelter.

A. C. 208 (sodium aerofloat) and Barrett No. 4 (coal-tar creosote) are added at the feed end of the ball mill at the rate of .02 pound per ton and .10 pound per ton, respectively. These act as collectors and have been found to work very satisfactorily on metallics. Z-6 Bear Brand (pentasol xanthate) is added to the classifier at the rate of .02 to .05 pound per ton. Aerofloat 25 is added at the head end of the flotation circuit at the rate of .05 pound per ton.

Cyanidation.- The tails from the flotation circuit are divided into two equal parts and go to No. 1 and No. 2 thickeners, where lime is added. These thickeners are each 24 by 8 feet. The overflow goes to the mill water-storage tank; the pulp goes through Nos. 1 and 2 agitators in series and thence through Nos. 3, 4, and 5 thickeners.

Pregnant solution is taken from No. 3 thickener. The overflow from No. 4 thickener goes to a weak pregnant-solution tank, where cyanide is added; it is then pumped back to No. 1 agitator. The overflow from No. 5 thickener is returned to No. 4 thickener. The pulp from No. 5 thickener goes to the tailing pond. The barren solution from the precipitation plant goes to No. 5 thickener.

The solution is maintained at 1.3 to 1.5 pounds of cyanide per ton and 1.2 to 1.5 pounds of lime per ton. The cyanide loss is about 0.7 pound per ton. Cyanide consumption due to ferrous and copper salts is negligible.

The pulp density of the feed to No. 1 agitator is maintained at 60 to 65 percent solids. In order to balance the solution, the density of the underflow from No. 5 thickener is also maintained at 60 to 65 percent solids. By properly controlling the pulp density at these two points, it becomes unnecessary to add water to the cyanide circuit, or to pump any from the cyanide circuit back to the mill storage tank, where it would get into the flotation circuit. The density is controlled by returning a part of the underflow from thickeners No. 1, 2, and 5 to the top of each. The greater amount of underflow returned, the greater will be the final pulp density.

About 80 percent of the water is returned to the mill storage tank, but only 60 percent is re-used because of the high lime content.

Precipitation.- The overflow from No. 3 thickener goes to a Merrill Crowe precipitating plant. The precipitate runs from 1/2 to 1.0 ounce of gold per pound. About 100 pounds is produced each month and sent to the Selby plant of the American Smelting and Refining Co. for refining.

Tailings disposal.- The tailings are impounded in an arroyo just south of the mill. A launder running across the arroyo, deposits the coarse material where it can be used for building a bank. The fine material settles at the up-hill end of the deposit. One man working about 1 hour a day keeps the dam built up. No water is reclaimed.

Power.- The connected horsepower in the mill is as follows:

Crusher	20
Conveyor	5
Ball-mill feeder	2
Ball mill	100
Classifier	2
6 flotation cells (2-1/2 each)	15
Concentrate thickener	2
Concentrate filter	1
Filter pump	2
Vacuum pump	3
Sampler	3
Elevator	1
Three 22-foot thickeners (3 each)	9
2 agitators (10 each)	20
Two 30-foot thickeners (5 each)	10
Filter press	10
Solution pump	2
Triplex pump	5
Miscellaneous motors	2
	214

Labor.- Ten men besides the mill superintendent are required to operate the mill three shifts a day. The mill payroll is as follows:

3 operators at 63 cents per hour	$15.12
3 helpers at 50 cents per hour	12.00
1 mechanic at 50 cents per hour	4.00
3 laborers at 43 cents per hour	10.32
Total daily payroll	41.44

Metallurgical data.- Metallurgical data for 1936 to the end of November are shown in the following tabulations:

Ball mill heads 20,500 tons.

	Assays	Contents
Gold	0.364 ounce per ton	7,462.926 ounces
Silver	.464 ounce per ton	9,509.920 ounces
Lead	.240 percent	98,342 pounds
Copper	.030 percent	12,040 pounds

Flotation concentrates 469.1305 tons.

	Assays	Contents
Gold	13.153 ounces per ton	6,170.395 ounces
Silver	14.944 ounces per ton	7,010.500 ounces
Lead	8.39 percent	78,674 pounds
Copper	1.03 percent	9,632 pounds

Recoveries in flotation circuit.

	Percent
Gold	82.68
Silver	73.72
Lead	80
Copper	79.5

Cyanide heads or flotation tails = ball mill heads - flotation concentrates = 20,500 - 469 = 20,031 tons.

	Assays	Contents, ounces
Gold	0.065	1,292.531
Silver	.125	2,499.420

Precipitates 1,295 pounds total

Gold	- - - -	854.14
Silver	- - - -	999.77

Final tails 20,031 tons

Gold	0.022	438.39
Silver	.075	1,499.65

Cyanide recoveries

Gold 11.45 percent of ball mill heads, 66.00 percent of the cyanide heads.

Silver 10.51 percent of ball mill heads, 40.00 percent of the cyanide heads.

Total recoveries

	Percent
Gold	94.13
Silver	84.23
Lead	80
Copper	79.5

Costs

The tonnages mined and milled during the first 11 months of 1936 are:

	Tons
Total ore mined and milled	18,568
Lease ore milled	1,697
Total from Octave	20,265
Custom ore	235
Total tons milled	20,500
Total concentrates produced	469.1305

Mining, 1935.- Development and ore-breaking costs for 1935 are shown in the following two tables:

Development costs, 1935

[Total feet, 2,034; tons milled, 23,951]

	Amount	Per foot	
Breaking:			
Labor	$8,870.90	$ 4.361	
Supplies	994.31	.489	
Supervision	1,146.23	.565	
Power	2,032.37	1.000	
Timber	146.62	.072	
Explosives	2,803.43	1.378	
Drill supplies	1,207.74	.594	$8.459
Tramming:			
Labor (sublevel)	754.09	.366	
Supplies do.	177.31	.087	
Labor (main level)	349.59	.172	
Supplies do.	103.93	.051	.676
Hoisting:			
Labor	937.05	.462	
Supplies	13.91	.006	.468
Shops:			
Labor	1,586.54	.780	
Supplies	912.09	.448	1.228
Miscellaneous:			
Labor	336.38	.165	
Supplies	1.03	.001	.166
Total amount	22,373.52	10.997	10.997
Per foot	11.00		
Per ton milled	.94		

Ore-breaking costs, 1935

[Tons broken, 23,200; tons milled, 23,951]

	Amount	Per ton mined	
Stoping:			
Labor	$40,005.61	$1.724	
Miscellaneous supplies	4,019.42	.173	$1.897
Supervision	3,618.34	.156	
Power	7,042.47	.304	
Timber	2,408.17	.104	
Explosives	9,314.93	.401	
Drill supplies	6,224.86	.268	1.233
Tramming:			
Labor (sublevel)	2,451.93	.106	
Supplies do.	975.48	.042	
Labor (main level)	1,750.93	.075	
Supplies do.	729.72	.034	.257
Hoisting:			
Labor	2,232.11	.096	
Supplies	71.96	.003	.099
Shops:			
Labor	6,547.56	.282	
Supplies	3,261.39	.141	.423
Miscellaneous:			
Labor	918.69	.039	
Supplies	7.85	.000	.039
Total	91,581.42		
Per ton mined			3.948

Milling, 1935.- Milling costs are shown in the following table:

Milling costs, 1935

[Tons milled, 23,951]

	Amount	Per ton milled	
General:			
Labor	$12,362.46	$0.517	
Supplies	10,623.17	.444	$0.961
Supervision	2,075.00	.087	
Power	14,367.13	.600	
Reagents	5,737.70	.239	
Royalties	217.71	.009	
Hauling concentrates	1,675.97	.070	1.005
Miscellaneous:			
Labor	4,173.84	.175	
Supplies	1,755.37	.073	.248
Total	52,988.35	2.214	2.214

General, 1935.- The general expense for 1935 is shown in the following table.

General expenses, 1935 (itemized)

[Tons milled, 23,951]

	Amount	Per ton milled	
Salaries	$4,450.00	$0.186	
Taxes	2,553.29	.106	$0.292
Engineering and assaying:			
Labor	2,469.11	.103	
Power and supplies	830.50	.035	.138
Water supply:			
Labor	219.95	.009	
Supplies	7.88	.000	.009
Insurance:			
Fire	400.00	.017	
Employees liability	7,413.26	.310	
Theft	50.00	.002	.329
Telephone and telegraph	240.00	.010	.010
Camp maintainance:			
Labor	1,591.36	.067	
Supplies	1,216.30	.051	.118
Boarding house	205.26	.008	
Traveling	642.37	.027	
Tucson office	2,396.00	.100	
Legal	70.00	.003	
Office supplies	387.49	.016	
Miscellaneous	94.15	.004	.158
Total	25,236.92	1.054	1.054

Total, 1935.- The total expenses for 1935, exclusive of costs of lease and custom ore for 1935 are:

Tons of ore milled	23,951
Development	$0.934
Mining	3.948
Milling	2.214
General	1.054
Total	$8.150

Total, 11 months 1936.- The development, mining, milling, general, lease ore, and custom ore expenses for the first 11 months of 1936 are:

Total tons milled, including custom ore, 20,500.

		Per ton milled	
Development.......	$35,384.64	$1.726	
Mining............	76,310.20	3.723	
Milling...........	47,095.51	2.297	
General expenses..	18,612.48	.908	$8.654
Cost of lease ore.	11,919.77	.581	
Cost of custom ore	1,632.18	.080	.661
Totals.......	190,954.78	9.315	9.315

Johnson Mine

Situation

The Johnson mine is 4 miles due north of Octave in the Weaver Mountains. It is served by a passable highway from Octave. The property consists of 5 patented and 5 unpatented claims owned by J. Smith of Los Angeles. It is operated under lease and option by the Johnson Gold Mines, Inc., Ralph Roseburry, President, 610 I. W. Helman Bldg., Los Angeles.

Water Supply

The mine makes about 3,000 gallons of water a day. The sump is pumped out about every fourth day and the water is utilized in the mill. Additional water for the mill is piped to the mill storage tank in a 2-inch gravity line from an old mine tunnel about 2,000 feet south of the mill. About 1,000 gallons a day is supplied from this source. A spring furnishes a supply of about 1,500 gallons a day, part of which is used for domestic purposes and part for the mill. It is piped from the spring to the mill storage tank and the domestic supply tank in a 2-inch gravity line 1,500 feet long.

Topography and Geology

The country about the mine is very rugged and precipitous. The elevation at the portal of the main adit level is 4,250 feet.

The country rock is granite. The vein bears northeast and southwest and dips from 28° to 30° to the north. A fine-grained basic dike rock is adjacent to the vein in most parts of the mine. The best ore seems to be associated with this dike and is sometimes above and sometimes below it. In places where both walls of the vein are granite, there is very little commercial ore. The vein consists principally of quartz filling in a fault fissure and is from one to two feet thick. The principal minerals are gold-bearing sulphides of lead, copper, iron, and zinc.

The vein is cut by two transverse faults, one on each side of the shaft. Ore has been mined on each side of the west fault, but the east one seems to cut off the vein entirely, as no ore has been encountered east of it.

Development

Development consists of a main adit level 470 feet long, with one level above and four below, connected by an incline shaft 530 feet deep on the dip of the vein. The sump of the shaft is about 30 feet below the sixth or lowest level. The levels are at intervals of 50 to 150 feet on the slope of the vein. There is a total of about 1,500 feet of drifting.

Mining

Raises are run every 35 feet from level to level (fig. 10). Breaking starts from the back of the bottom level, and the ore is shoveled from the track until the stope has been advanced far enough to start stulling and backfilling. After stulling and backfilling have been started, the ore is broken from the back of the stope and shoveled to the raises on each side. Loading into cars is done from chutes at the bottom of the raises.

During October 1936 some ore was mined on the surface by underhand stoping on the outcrop. This was only a temporary arrangement to keep up production while one of the underground stopes was being timbered and prepared for production.

The ore is from 1 to 2 feet thick. From 2 to 3 feet of loose rock above the ore must be broken; the waste is used as back filling. The filling is piled against lagging that is held in place by the stulls. One row of stulls is placed along the bottom of the stope near the bottom level and a row about 2 feet in from each edge of the raises. After the stope is finished there remains a filled section 27 feet wide with an open space 8 feet wide on each side. It has been found desirable and in some cases necessary to leave small pillars at the lower corners of the stopes.

The stulls used are of round native timber and from 6 to 10 inches in diameter. Two-inch plank is sometimes used for lagging but almost any available scrap material is satisfactory.

The chutes consist of a bottom, side boards, and wing boards, and are constructed mostly of 2-inch plank. Sometimes steel sheets are used on the bottoms.

Mounted wet jackhammers with 7/8-inch hexagon steel, 18-inch changes, and Carrbits are used in the stopes and all development headings. Eleven holes are required to break a 4-foot drift round.

During October 1936 no stoping was being done underground. About 10 tons of ore a day was being produced from an open cut on the vein on the surface, and from 8 to 10 tons a day was produced by development. One

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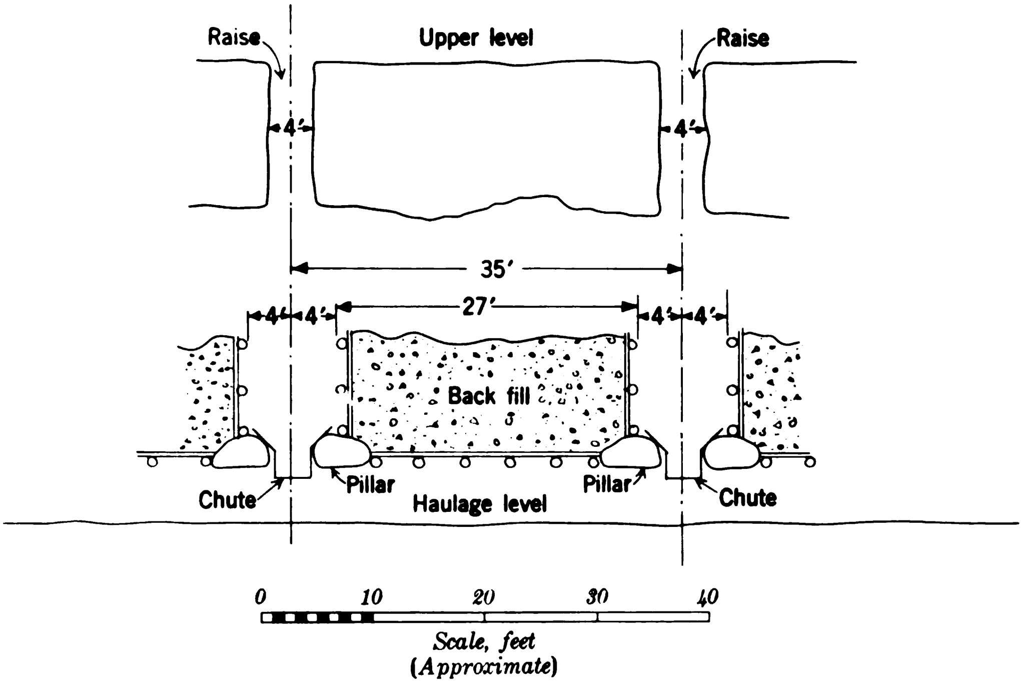

Figure 10.—Method of stoping, Johnson mine.

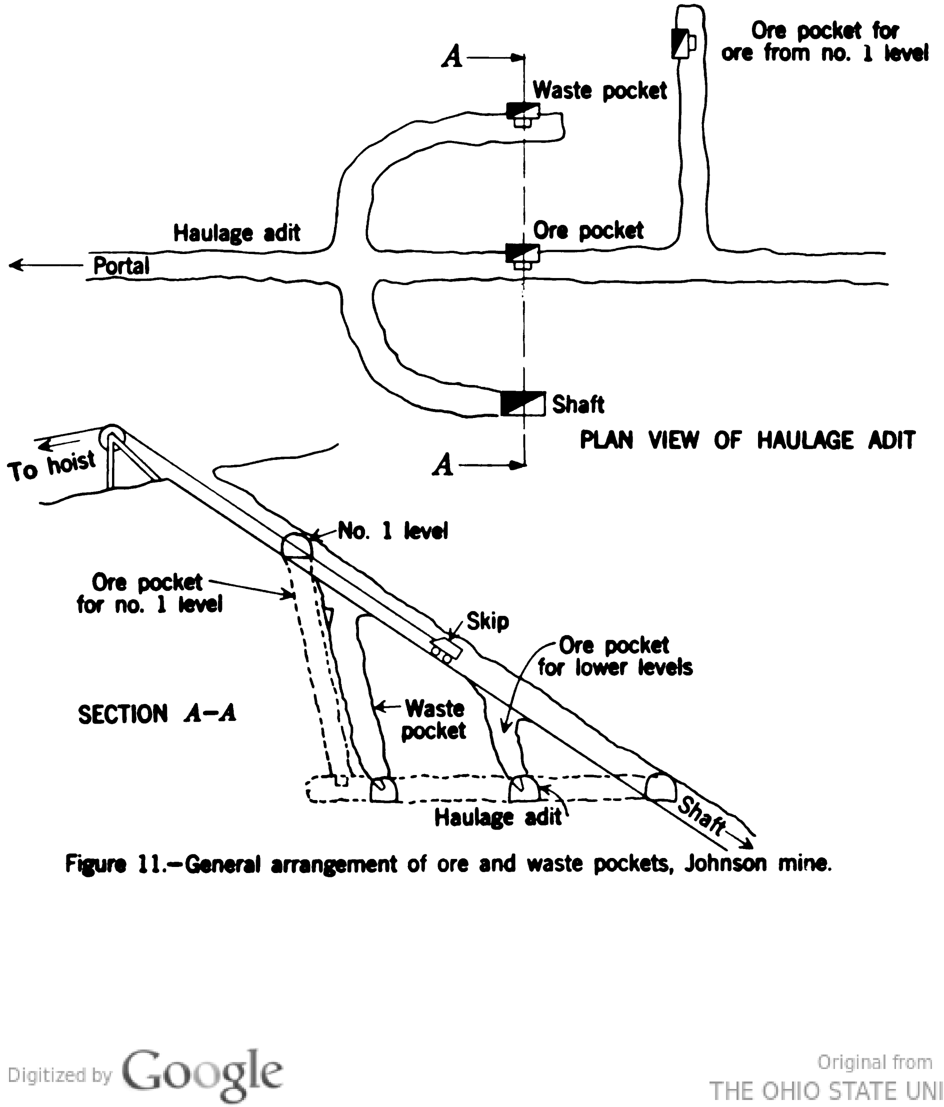
A
A
Waste pocket
Ore pocket for ore from no. 1 level
Haulage adit
Portal
Ore pocket
Shaft
PLAN VIEW OF HAULAGE ADIT
To hoist
No. 1 level
Ore pocket for no. 1 level
Skip
Ore pocket for lower levels
SECTION A–A
Waste pocket
Haulage adit
Shaft

Figure 11.—General arrangement of ore and waste pockets, Johnson mine.

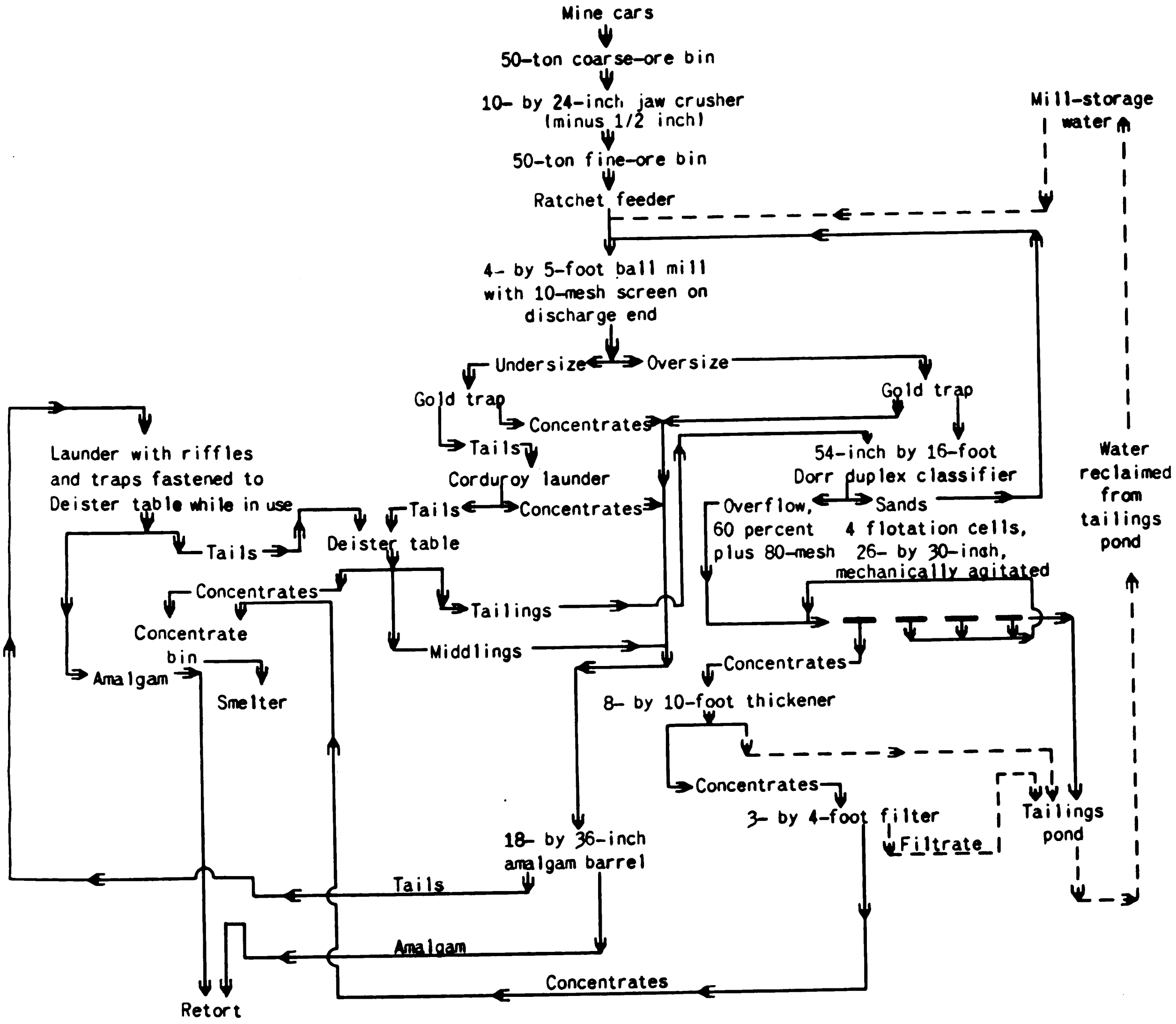
Mine cars
50-ton coarse-ore bin
10- by 24-inch jaw crusher (minus 1/2 inch)
50-ton fine-ore bin
Ratchet feeder
Mill-storage water
4- by 5-foot ball mill with 10-mesh screen on discharge end
Undersize
Oversize
Gold trap
Concentrates
Tails
Gold trap
Corduroy launder
Tails
Concentrates
54-inch by 16-foot Dorr duplex classifier
Overflow, 60 percent plus 80-mesh
Sands
4 flotation cells, 26- by 30-inch, mechanically agitated
Water reclaimed from tailings pond
Launder with riffles and traps fastened to Deister table while in use
Tails
Deister table
Concentrates
Tailings
Middlings
Concentrate bin
Amalgam
Smelter
Concentrates
8- by 10-foot thickener
Concentrates
3- by 4-foot filter
Filtrate
Tailings pond
18- by 36-inch amalgam barrel
Tails
Amalgam
Concentrates
Retort

Figure 12.- Flow sheet, Johnson mill (50-ton capacity).

machine was operating two shifts a day in the west drift heading of No. 1 level; one was operating one shift a day in the east drift heading of No. 5 level, and one, two shifts a day on the surface above No. 1 level. The two machines in the drift headings produced some ore, but most of the breakage was waste, due to the narrowness of the vein. The machine on the surface was breaking mostly ore.

The ore and waste from the levels below the main adit level are dumped directly from the mine cars into a 1-ton skip and hoisted to ore and waste pockets at the main adit level (fig. 11). The ore from the surface is run through a raise to No. 1 level and then trammed to a separate ore pocket that draws from the main adit level.

The ore and waste is trammed from the ore and waste pockets of the main adit level by one contract trammer who is paid 10 cents a car. The distance from the waste pocket to the dump is about 500 feet, and the distance from the ore pockets to the mill bins is about 650 feet.

The mine payroll is as follows:

1 contract trammer at 10 cents a car		
5 miners at	$4.50	$22.50
5 muckers at	4.00	20.00
1 hoistman at	4.50	4.50
1 timberman at	4.75	4.75
1 foreman and blacksmith at	5.00	5.00

Compressed air is furnished by a compressor of 180-cubic-foot capacity operated by a 40-horsepower motor. A compressor of 300-foot capacity, direct-connected to a Diesel engine, is used as a stand-by for emergencies. The hoist is operated by a gasoline engine.

Milling

The normal capacity of the mill is 50 tons a day. During October and November it was operated one 12-hour shift a day, milling from 18 to 20 tons of ore. Values are recovered by gravity concentration, flotation, and amalgamation. Some of the ore from the upper levels is highly oxidized, making amalgamation necessary. The flow sheet of the mill is shown in figure 12.

Crushing and grinding.- The ore is trammed from the mine by hand and dumped into a 50-ton coarse-ore bin. From the coarse-ore bin it goes through a 10- by 24-inch jaw crusher, where it is crushed to about 1/2 inch and is discharged into a fine-ore bin of 50-ton capacity.

From the fine-ore bin the ore is fed by a ratchet feeder into a 4- by 5-foot ball mill using 4-inch balls. The mill had not been in operation long enough or steadily enough to determine ball consumption definitely. The classifier overflow is 94 percent minus 80 mesh.

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Gravity concentration.- A 10-mesh screen on the discharge end of ball mill makes a rough classification of the ball-mill discharge. The oversize goes through a gold trap or hydraulic separator and then to a 54-inch by 16-foot Dorr duplex classifier in closed circuit with the ball mill. The undersize goes through a hydraulic separator, then through a corduroy launder and then over a Deister sand table. Concentrates, middlings and tails are taken from the Deister table. The concentrates go to the concentrate bins, where they are mixed with flotation concentrates and dried for shipment. The tails go to the Dorr classifier. The concentrates from the gold traps and the corduroy launder and the middlings from the Deister table are amalgamated in an amalgamation barrel.

Flotation.- The overflow from the Dorr classifier goes to four 26- by 30-inch mechanically agitated flotation cells. Finished concentrates are taken from the overflow of the first cell. The overflow from the other three cells is returned to the first cell.

Z-5 and Z-6 are added at the classifier overflow at the rate of about 0.3 pounds per ton of ore. Aerofloat is added at the classifier overflow and aerofloat and pine oil at the flotation cells. The amount of these reagents used is quite variable and depends on the amount of oxidized ore. For highly oxidized ore, X-1 is used as a frother.

The flotation concentrates are first dewatered in an 8- by 10-foot Dorr thickener and then filtered in a 3- by 4-foot Oliver filter. The overflow from the thickener and the filtrate from the filter are run into the tailings. Water that separates from the tailings at the tailings pond is returned to the mill storage tank. About 50 percent of the water is reclaimed.

Amalgamation.- The concentrates from the gold traps and the middlings from the Deister table are amalgamated in an 18- by 36-inch amalgamation barrel. The amalgam is retorted and melted in the assay office. The tailings from the amalgamation barrel are run over a launder provided with riffles and traps. This launder is fastened to the Deister table and the material fed into it by hand. The purpose of this operation is to catch any amalgam that remains in the tailings. The tailings pass through the launder and then run over the Deister table, where the sulphide particles are saved.

Detailed metallurgical and cost data were not available because the mill had not been in operation long enough at the time of the visit in October and November 1936. The ratio of concentration is approximately 40 to 1. The table concentrates run about $550 a ton and the flotation concentrates about $150 a ton. Approximately 50 percent of the total recovery was made by amalgamation as most of the ore milled was from the upper oxidized levels.

The mill is operated by the mill superintendent, one operator, and an assayer.

Power.- Electric power is furnished by the Arizona Power Co. Current is brought to the property at 11,000 volts and stepped down to 440 volts for motors and 110 volts for lighting. Connected horsepower is as follows:

Crusher	25
Conveyor	3
Ball mill	40
Line shaft for machine shop	10
Classifier	5
Flotation cell	7.5
Reagent feeders	.75
Thickener	3.0
Filter, vacuum pump, and compressor	7.5
Total	101.75

Meyers Mine

Situation

The Meyers mine is about 1 mile northwest of Octave on the west side of Weaver Gulch. It is served by a branch road of the county highway from Congress Junction to Octave.

The property consists of seven claims held by location by the Consolidated Mining and Development Co., George W. Meyers, of Octave, president. It is operated under lease by George W. Long and associates, of Phoenix.

Geology

The country rock is granite. The vein bears N. 60° E. and dips to the northwest at about 30°. It is from 1 to 2 feet thick and consists of quartz filling in a fault fissure. The mineralization consists principally of iron pyrite with small amounts of lead, zinc, and copper sulphides. Gold is the only metal present in commercial quantities.

Development

Development consists of an incline shaft 175 feet deep on the dip of the vein and two levels at 85 and 145 feet from the collar of the shaft. On the 85-foot level a drift extends 150 feet to the east and another 180 feet to the west from the shaft. On the 145-foot level there is 100 feet of drifting on the east and 130 feet of drifting on the west side of the shaft. The sump of the shaft is 30 feet deep below the 145-foot level.

Mining Methods

Drilling and breaking start from the back of the drift. The ore bodies are too small and irregular to warrant running raises before starting a stope. The ore is worked down by hand from the top of the stope to the level where it is shoveled into cars and trammed to the shaft. Stulls are used to support the hanging wall wherever necessary, and the waste sorted from the ore is left in the stope as filling.

Jackhammers are used in all parts of the mine. In the stopes they are used with or without the mountings, as conditions require, but they are always mounted in the development headings. Steel is sharpened by hand. Chisel bits on 7/8-inch hexagon steel are used in all machines.

In November 1936 one machine was operating one shift a day in the west drift heading of the 145-foot level and two machines were operating one shift a day each in a stope above the west end of the 85-foot level. This stope was about 50 feet long and was broken through to the surface in several places. Each machine was operated by a miner and a helper. Two muckers did the mucking and tramming on both levels.

The mine makes about 5 gallons of water a minute. This is pumped from the sump of the shaft with a boiler feed pump operated by air from the compressor and stored in a 2,500-gallon tank at the surface.

Operations were begun in May 1936 and the first ore was shipped in June. Four carloads of ore were shipped to the Clarkdale smelter and two to the Octave mill. The ore is hauled by contract from the mine to the Octave mill for 50 cents a ton.

Equipment consists of a small blacksmith forge for sharpening steel, a 1-ton skip operated by a single-drum gasoline hoist, an electric compressor of 360 cubic foot capacity operated by a 50-horsepower electric motor, a No. 3 Buffalo blower (not in use), and an ore bin of about 30 tons capacity.

Power is purchased from the Arizona Power Corporation and is brought to the mine at 11,000 volts and stepped down to 440 volts for use in the motor.

The payroll is as follows:

3 miners	@	$3.50	$10.50
3 helpers	@	3.00	9.00
2 muckers	@	3.00	6.00
1 blacksmith	@	3.50	3.50
1 hoistman	@	4.00	4.00
Total			33.00

Board and quarters are furnished by the company for $1.25 a day.

Yarnell Mine

Situation

The Yarnell mine is about a mile and a half south of the village of Yarnell in Yavapai County at the summit of the Weaver Mountains. It is about a quarter of a mile east of the main highway from Wickenburg to Prescott and about 4 miles northeast of Congress Junction, the nearest railroad loading station.

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The property consists of 5 patented and 7 unpatented claims owned by the Security Trust Co. of Prescott. It is operated under lease and option by the Yarnell Mining Co., Lloyd W. Moultrie, president, 3012 West 7th Street, Los Angeles.

Topography and Geology

The country around the mine is rough and precipitous and drains partly north into Kirkland Creek and partly south into the Hassayampa River. The elevation at the mill is about 4,800 feet.

The country rock is essentially granite and beds of schist that run in a general northeasterly and southwesterly direction. The vein is in granite and bears N. 45° E. and dips to the northwest at about 35° or 40°. The mineralization is in a shear zone 120 feet wide. Ore bodies occur near both hanging and footwalls. The principal ore bodies are in the footwall. The principal minerals are free gold and gold-bearing sulphides of copper, lead, and iron, chiefly iron. In some places mineralization is fairly regular, but in others tongues run out into the footwall for considerable distances.

Water Supply

The water supply is from two drilled wells, 67 and 82 feet deep. Two pumps, each operated by a 5-horsepower motor, raise the water from the water level to a storage tank of 20,000 gallons capacity. The two wells furnish a minimum supply of 5 to 6 gallons a minute during the dry season and a maximum of 35 to 40 gallons during the rainy season.

Development

The old workings consist of three adit levels connected by raises. The upper two levels are on the vein and about 100 feet apart on the slope. The lower level is about 250 feet below the middle adit on the slope. A limited amount of mining was done from the upper two levels, especially from the lower of the two, by former operators. The lower level consists of a crosscut about 470 feet long from the north side of the mountains to the vein and about 1,000 feet of drifting on the vein. The drift extends from the point where the crosscut intersects the vein to the surface on the south side of the mountain. About 500 feet of this drifting was done by the present operators.

New development consists of the Human shaft, about 400 feet to the southwest of the south portal of the lower level of the old workings. The shaft is 210 feet deep, including 20 feet of sump, with three levels at distances of 75, 125, and 190 feet from the surface. In October and November the mill was operated mostly on development ore from this part of the mine.

Mining Methods

A definite system for mining the ore has not been developed by the present operators. All ore that has been milled to date has come from development and from short prospect raises. The ground is heavy and it is evident that the stopes will have to be supported as the ore is taken out.

Stoping by the former operators was not extensive. Apparently the stopes were carried up for 25 to 35 feet above the level and left open, with the hanging wall supported by stulls. Many of these old stopes are caved and, therefore, their exact extent is not known. There are some old chutes of the conventional type in some of the old workings, which would indicate that the ore ran by gravity or at least with a minimum amount of shoveling. In other places, it appears that the ore was shot from the back of the drift and shoveled.

Air for present operations is supplied by a compressor of 285 cubic feet capacity driven by 50-horsepower induction motor. This compressor is at the north portal of the bottom level. The air is piped through the tunnel to the south portal and down the hill to the workings of the Human shaft.

There is a gasoline hoist and a gasoline blower at the Human shaft. The ore is hoisted in a 1-ton skip and dumped into a bin of about 25 tons capacity at the portal of the shaft. From this bin, it is hauled by a company truck to the mill, a distance of about 1/2 mile.

The mine payroll is as follows:

3 machine men	@	$4.40	$13.20
5 muckers	@	3.30	16.50
3 top men	@	3.30	9.90
3 hoistmen	@	3.30	9.90
2 truck drivers	@	3.30	6.60
1 foreman	@	5.50	5.50
Total			61.60

Milling

General.- The mill, of 75 tons capacity, was built late in 1935 and began operating in January 1936. It is essentially a flotation plant, but a product running about $18 a ton in gold is taken from pilot tables.

The flow sheet was changed a number of times after the mill began operating. Pulsating jigs were tried and an attempt was made to cyanide the overflow from a concentrate thickening cone. Figure 13 shows the flow sheet as it was in April 1937.

Crushing and grinding.- The ore is dumped into a coarse-ore bin of 80 tons capacity. From this bin it is discharged into a 9- by 15-inch jaw crusher that crushes to about 3/4 inch. A 12-inch belt conveyor takes the

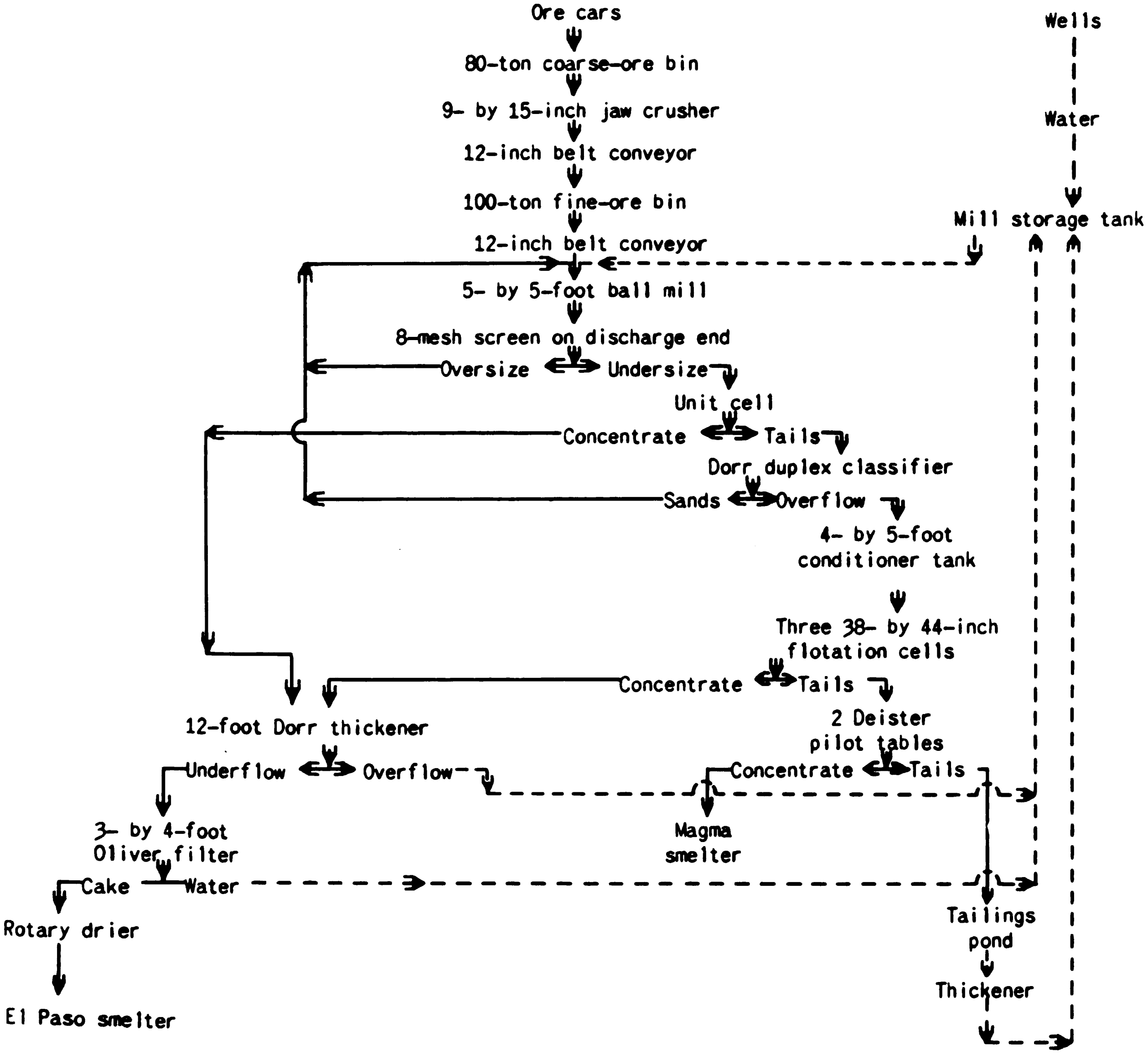

Figure 13.- Flow sheet, Yarnell mill (daily capacity, 75 tons).

discharge from the crusher to a fine-ore bin of 100 tons capacity, from whence the ore is taken by another 12-inch belt conveyor to a 5- by 5-foot ball mill, in which 3-inch cast-iron balls are used.

An 8-mesh screen on the discharge end of the ball mill removes the coarse particles, which are returned to the feed end. The oversize from a Dorr duplex classifier operated in open circuit with a unit flotation cell also is returned to the ball mill.

The ball consumption is about 2 pounds per ton of ore treated. Cast-steel liners that cost $300 per set last about 5 months when the mill is operated at a capacity of 80 tons a day.

A screen analysis of the classifier overflow is about as follows:

	Percent
Minus 48 mesh	100
Minus 48 mesh plus 65 mesh	12
Minus 65 mesh plus 100 mesh	18
Minus 100 mesh plus 200 mesh	24
Minus 200 mesh	46
	100

Concentration.- The tails from the unit cell go to a Dorr duplex classifier and the concentrates to a Dorr thickener. The overflow from the classifier goes to a 4- by 5-foot conditioning tank and then to three 38- by 44-inch mechanically agitated flotation cells. The concentrates from the first cell go to the Dorr thickener. The overflow from the second and third cells is returned to the first. The pulp from the Dorr thickener is filtered in a 3- by 4-foot drum-type filter. The filter cake is dried in a rotary drier. The overflow from the Dorr thickener and the filtrate from the filter are returned to the mill storage tank. The heads run from $8 to $10 a ton and the concentrate from $150 to $200 a ton.

Reagents are added to the circuit as follows:

Z-6,	- 0.075 pound per ton at the flotation cells.	
No. 15 Aerofloat	- .05 pound per ton at the ball mill intake.	
No. 2 Tarol	- .02	do.
No. 208	- .008	do.

The tailings from the flotation cells are run over two Deister pilot tables. From these tables a cut is taken, which runs about $18 per ton in gold and contains most of the fine metallic iron from the grinding balls. About 300 pounds of this product is made a day. It is shipped to the Magma Smelter at Superior. The tailings from the tables are run to the tailings pond.

Labor.- During October and November the mill was operated two shifts a day and treated about 35 tons of development ore. The mill heads have averaged about $7 a ton since the Human shaft was started. Fresh water is used at the rate of 5 gallons per minute and reclaimed water at the rate of 30 gallons per minute. The mill payroll is as follows:

1 foreman and mechanic	@	$5.00	$5.00
1 crusherman	@	3.00	3.00
1 assayer	@	4.00	4.00
2 operators	@	4.00	8.00
2 helpers	@	3.00	6.00
1 cyanide operator	@	4.00	4.00
Total			30.00

Power.- Power is purchased from the Arizona Power Co. Current is brough to the mine at 44,000 volts and stepped down to 440 and 100 volts for power and lighting.

The connected horsepower in the mill is as follows:

Crusher	20
Conveyor	1
Ball mill	50
Classifier	2
Unit cell	5
Conditioner tank	3
Mine flotation cells	10
Three tables, 1 each	3
Tailings pump	3
Filter	3
Thickener	5
Agitators, 3 each	9
Solution pump	2
Total	116

Besides this, there are two 5-horsepower motors for operating the pum that supply fresh water from the wells.

In September 1936 the total power consumption was 32,480 kw.-hr. This included the 50-horsepower motor that runs the compressor and current used for lighting. The cost was $783, or 2-1/2 cents per kw.-hr.

Tailings disposal.- The tailings are impounded in a natural drainage channel on the side of a hill about 100 feet east of the mill. The locatio is near the summit of the mountains, so that drainage from above can be controlled easily.

The tailings pulp is run to the downhill end of the pond, where most of the sands collect. The slimes and the water collect at the opposite end of the pond, next to the hill. The dam is built up of coarse material on the downhill side as necessity requires. The water is taken from the pond by a pipe that runs under the deposit from the uphill side to a thickener below the deposit. Additions are made to the upper end of this pipe as the deposit is built up. Water is pumped from the thickener to the mill storage tanks.

Freight and smelter.- The company delivers the concentrates at the village of Yarnell, where the flotation concentrate is picked up by a trucking company and taken to the smelter at El Paso. The concentrate is often stored in the trucking company's warehouse at Phoenix until it is convenient to take it to El Paso with other freight. This causes long delays and, consequently, the arrangement has not been entirely satisfactory.

The trucking rates to El Paso are $10 a ton, which is about $1 a ton more than the railroad rate from Congress Junction for carload lots of ore of the same class. The railroad rates are not taken advantage of because it requires too long to produce a carload of concentrates. The trucking to Congress Junction would just about offset the difference in rates.

Total marketing costs are about $25 per ton of concentrate.

Reese Mine

Situation

The Reese mine is in the Martinez district at the summit of the Date Creek Mountains, about 6 miles due north of Congress Junction. It is served by a passable branch road from the Congress Junction-Hillside Highway, which lies about a mile to the east of the mine.

The property consists of 2 patented and 11 unpatented claims. It is owned by J. L. Reese of Congress Junction and is operated under lease by R. F. Thatcher of Wickenburg.

Topography and Geology

The Date Creek Mountains are low but quite rugged. The highest peaks are about 4,500 feet above sea level. The summit of the range at the mine is about 3,800 feet above sea level.

The country rock is granite with diorite intruded along the plane of the vein. The vein bears northwest and southeast and dips to the northeast at about 30 . At the southern end of the property the vein consists principally of quartz, which varies in thickness from 2 to 4 feet. The principal minerals are gold-bearing sulphides of iron, lead, and copper, with some zinc. At the northern part of the property the vein seems to be more altered and oxidized. The best ore occurs with yellow and brown oxides of iron.

Development

The property is developed extensively through two inclined shafts on the vein. One shaft at the southern part of the property is 1,180 feet deep and the other at the northern part is 300 feet deep. The bottom of the south shaft connects with the surface by an adit crosscut 700 feet long. There are a number of levels from each of these shafts, but the extent of the workings is unknown because of caving.

Equipment

Mine equipment consists of a gasoline hoist, a gasoline compressor, and two jackhammers. Besides this, it was necessary to buy a truck for hauling groceries and taking the men to and from work.

Mining Methods

Mining was started in the upper levels of the south shaft in March 1936. Shipments from this part of the mine ran from $9 to $15 a ton in gold. Later on this part of the mine was abandoned and mining was begun on the upper level of the north shaft. Shipments from here run from $40 to $60 a ton in gold.

Mining consists of stripping from 2 to 3 feet of waste rock from above the ore by blasting and then digging the ore loose with a pick. The ore ranges in thickness from 6 to 18 inches. Appreciable amounts of gold seem to occur in the fractured parts of the rock adjacent to the vein, as samples of the fines from the waste dump run up to $8 a ton in gold.

Drilling is done with mounted jackhammers using 7/8-inch hollow steel and chisel bits. The steel is sharpened at the mine.

In November 1936 operations consisted of mining above the first level south of the shaft and drifting south on the same level. By careful mining, the grade of the ore was kept at $40 to $60 a ton. Carload shipments of 45 to 50 tons each are made to the Magma smelter at Superior about every two weeks.

Labor

The payroll in November was as follows:

			Per day
3 miners	@	$5.00	$15.00
4 muckers	@	4.00	16.00
2 hoistmen	@	5.00	10.00
1 cook	@	2.00	2.00
Total			43.00

The hoistman runs the hoist, takes care of the compressor, and does the topping. Quarters are furnished, but there is a charge of $1 a day for board.

Trucking, Freight, and Smelter

Trucking rates to Congress Junction are $1.50 a ton. If the road from the main highway to the mine were improved, this rate probably could be cut to $1 a ton. For 80,000-pound minimum cars, the freight rates from Congress Junction to the Magma smelter at Superior are as follows:

Metal value	Rate per ton
Up to $15	$2.14
$15 to $20	2.40
$20 to $25	2.50
$25 to $30	2.60

For metal values over $30, the rates are the same for 80,000 minimum cars as for 60,000 minimum cars. (See freight rates for the Wickenburg area, page 8.)

Treatment charges are $3.50 a ton for ores having metal values up to $15 a ton and 10 percent additional of the gross value of the ore for any value over $15.

Costs

Total equipment and operating costs, from the time the mine started in March 1936 to September 1,1936 are as follows:

Equipment:

Gasoline hoist	$250.00	
Gasoline compressor	1,350.00	(not paid for)
Rock drills	138.00	
Picks and shovels	63.00	
Drill steel	22.00	
Pipe, hoses, etc.	250.00	
Haulage	90.00	
Total	2,163.00	

The truck was purchased on a time-payment plan and the payments are figured as operating expenses.

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Operating expenses:

March 1, 1935 to August 30, 1936.

Total, 802.47 tons.

	Total	Per ton
Labor	$4,200.00	$5.23
Gasoline for hoist and compressor	490.00	.61
Lubricating oil	66.00	.08
Powder	173.00	.21
Caps and fuse	127.00	.16
Groceries	1,475.00	1.84
Ore hauling	720.00	.90
Gas and oil for truck	246.00	.31
Cash payment on truck	375.00	.47
Assaying	96.00	.12
Repairs on old truck	74.00	.09
Tires and tubes	61.00	.08
Timber	220.00	.27
Total	8,323.00	10.37

Smelter Receipts

Dry tons	Assay value	Freight per dry ton[1/]	Treatment per dry ton	Receipts
46.16	$ 9.66	$ 2.17	$ 3.50	$ 184.58
49.41	11.59	3.97	3.50	203.02
45.76	9.02	2.20	3.50	152.00
51.27	11.27	2.17	3.50	288.44
47.39	8.05	2.18	3.50	112.46
51.70	6.44	2.16	3.50	40.25
49.60	15.45	2.56	3.55	462.19
50.95	14.16	2.61	3.50	411.05
52.88	16.10	2.60	3.61	523.36
44.60	18.99	2.56	3.90	557.82
51.43	15.45	2.62	3.55	479.14
45.23	12.88	2.66	3.50	303.95
40.27	21.57	2.98	4.16	583.64
36.31	23.90	3.20	4.39	592.58
31.77	35.42	3.20	5.54	847.11
33.65	40.80	7.05	6.00	936.64
42.63	62.79	4.27	6.00	2,243.01
31.46	21.57	2.70	4.16	462.19
802.47				$9,383.43

1/ Freight includes demurrage.

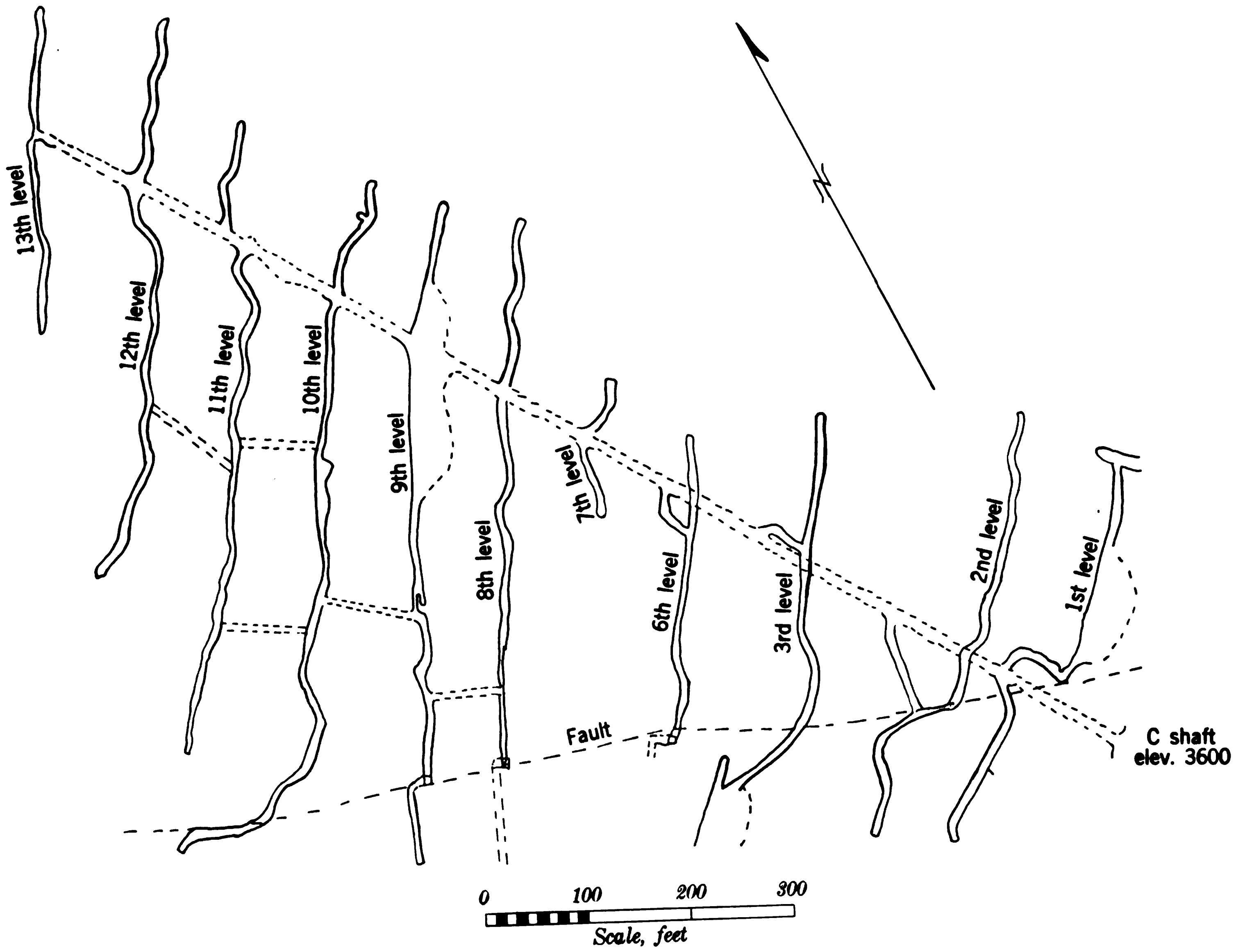

Figure 14.—Plan of workings, Alvarado mine.

Alvarado Mine

Situation

The Alvarado mine is about 3 miles northeast of Congress Junction in the foothills of the Weaver Mountains. The property is owned and operated by the Liberty Hills Gold Mines, Ltd., R. P. M. Davis, president, 2356 Hollyridge Drive, Hollywood, Calif.

History

The mine is reported to have had a small production prior to 1905 from two incline shafts, one 800 feet deep and the other 1,300 feet deep. The surface equipment was removed in 1920; new equipment was installed by the present operators in 1935. Up to November 1936, work has consisted principally of development.

Geology

The country rock is granite. The Alvarado vein bears N. 30° E. and dips from 25° to 30° to the southeast. Rhyolite and diorite are intruded along the plane of the vein. In the upper part of the vein the mineralization is between the rhyolite below and the diorite above. From about the eighth level down the relative position of the rhyolite and diorite is reversed, with the mineralization below the diorite. The vein throughout the mine is conformable in dip and strike with the diorite. In some places the diorite is mineralized and comprises considerable commercial ore.

The vein averages about 3-1/2 feet in width. Mineralization occurs principally as iron sulphide. Small amounts of lead and zinc sulphides also are present and there is some copper in the form of chalcopyrite.

The vein is cut by a fault that bears N. 70° W. and dips 80° to the north. The horizontal displacement of the vein due to this fault is from 35 to 45 feet, depending on the dip of the vein. The 1,300-foot shaft intersects the fault at about 100 feet from the collar. From this point almost to the eighth level the shaft is above the vein and on all of the intervening levels the vein had to be reached by crosscutting to the south.

Development and Mining Methods

Virtually all development is from the two inclined shafts, both of which are on the dip of the vein. The 800-foot shaft is inaccessible and the extent of development unknown. There are 11 levels from the 1,300-foot or C shaft, as it is known locally. The total drifting on these levels is more than 6,000 feet. Most of the drifting, from the sixth level down, and all of the raising were done by the present operators. Five raises, from the 9th, 10th, 11th, and 12th levels, have a total length of about 500 feet. Figure 14 shows the underground workings from C shaft.

Former operators took limited amounts of ore from the 1st, 3rd and 9th levels. Aside from this, all of the ground developed from C shaft might be considered "virgin."

During 1935 the shaft was repaired; development work was begun in the latter part of the year.

In November 1936 development work consisted of drifting south on the 6th, 8th, and 13th levels and raising from the 11th to the 10th level.

When the fault is encountered by a drift, a short raise is driven perpendicularly to the plane of the vein and in the plane of the fault. Driftin is continued from the point at which the raise intersects the vein on the opposite side of the fault. The purpose of this practice is to cut down development footage as much as possible. The vein generally can be picked up by 10 or 15 feet of raising, whereas from 35 to 45 feet of crosscutting would be necessary. The practice is objectionable in that it complicates mining operations.

The raises in the vein between levels are run about 8 feet wide and of the thickness of the ore. Breakage from the raises is removed by slushers operated by double-drum hoists.

Ore and waste are hoisted to the surface in a 2-ton skip and dumped in a bin of about 25 tons capacity. The material is drawn from this bin by a top man and trammed either to the ore dump or the waste dump. Tramming and hoisting can easily be regulated so that the ore and waste can be trammed separately.

Drilling is done one shift a day in each heading, as the compressor has capacity for only two drills. Two headings are drilled on each shift and are loaded out on the opposite shift. Three-inch drifters are used in two of the drifts. Jackhammers are used in the raise and the other drift. One-inch hexagon steel is used in all of the machines. Detachable bits are used in raises only.

Three motor-driven blowers are used for ventilation. Water is pumped by a 2-stage centrifugal pump operated by a 25-horsepower motor. The mine makes about 6 gallons a minute.

It is proposed to mine the ore by open-stope methods and mechanical slushing. The management believes the ore should run $10 a ton and have a width of 3 feet in order to permit mining and milling at a profit.

The best and most persistent values are on the south side of the shaft, and it is here that all development work is being done.

Surface equipment consists of a 10- by 12-inch, single-stage, motor-driven compressor of 360 cubic feet capacity, a 75-horsepower, single-drum, electric hoist, and a blacksmith shop with a pneumatic drill sharpener.

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Underground equipment consists of two double-drum electric hoists for slushing, three motor-driven blowers, a 2-stage centrifugal pump, an air pump for sinking, and several drifters and jackhammers with mountings.

Power

Power is purchased from the Arizona Power Corporation. The transformers are furnished by the power company.

Labor

In November 1936 the payroll was as follows:

8 miners	@	$4.50	$36.00
10 muckers	@	4.00	40.00
2 hoistmen	@	4.50	9.00
1 blacksmith	@	5.00	5.00
1 shift boss	@	6.00	6.00
Total			96.00

The slusher operators are rated as miners.

Congress Mine[6] (Idle)

Topography and Geology

The Congress mine is 3 miles by road northwest of Congress Junction. It is in a comparatively level country at the southern base of the Date Creek Mountains at an elevation of 3,400 feet.

The country rock consists of a coarse-grained granite intruded by basic dikes. There are several veins on the property, the principal ones being the Congress, the Niagra, and the Queen of the Hills. The Congress vein bears roughly east and west and dips to the north at 20° to 30°. It occurs largely within a basic greenstone dike with the ore shoots mostly near the footwall. The vein filling consists principally of quartz, with considerable amounts of iron sulphide. Galena is rarely present.

History and Production

The property was located sometime previous to 1887, when it was sold to "Diamond Joe" Reynolds for $65,000. Reynolds did some development work and built a 20-stamp mill with vanner tables for concentrating the ore. Amalgamation was never very successful, although the ore near the surface was highly oxidized. Very little was known of the cyanide process at this time, and as a result of metallurgical difficulties the early operations were not profitable.

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[6] Wilson, Eldred D., Cunningham, J. B., and Butler, G. M., Arizona Lode Gold Mines and Gold Mining: Arizona Bureau of Mines Bull. 137, Aug. 15, 1934, pp. 69-73.

Operations became more successful when the development work was carried to the lower sulphide levels, where the ore was better suited to gravity concentration. Good recoveries were impossible, however, because of inefficient grinding by stamps and concentrating without classifying. Later on, tailings from these early operations were treated by cyanidation with a good extraction.

The property was operated by Reynolds from March 1889 until his death in August 1891. During the three years that followed, production was discontinued, but the shaft was sunk to a depth of 1,000 feet on the dip of the vein, the mill was enlarged from 20 stamps to 40 stamps, and additional necessary vanners were added. Later on, cyanide tanks were added.

In 1894 production was resumed under new ownership. Except for a reorganization of the company in 1901, operations continued without interruption until 1910. By that time, practically all of the known ore reserves were exhausted and operations were discontinued. In 1920, the surface equipment, and a 4-mile railroad leading from Congress Junction to the mine were dismantled. In 1923, 1925, 1926, and 1931 lessees shipped a few cars of ore from the property. In 1928 several thousand tons of mine dump material was treated by combined gravity concentration and flotation. In 1931 the Southwest Metal Extraction Corporation treated 10,000 tons of mill tailings by cyanidation. In 1934 the Illinois Mining Corporation began treating mine dump material in a plant equipped with ball mill, tables, and cyanide tanks, but operations were suspended after a few weeks' run.

The total recorded production from 1899 until 1910 was $7,649,497. Of this, $155,652 was from crude ore, $4,695,994 from concentrates, and $2,797,55 from cyanide bullion. The production in bullion was 388,477 ounces of gold and 345,598 ounces of silver. As this was from 692,332 tons of ore, a net recovery of $11.81 a ton is indicated, figuring gold at $20.67 and silver at $0.60 an ounce. The tailings assay about $1.20 a ton, which indicates a gross value of about $13.00 a ton.

Development

The mine is developed very extensively through seven shafts. Nos. 1, 2, and 3 shafts are on the Congress vein and are 1,100, 1,700 and 4,000 feet deep, respectively. Nos. 4, 5, and 6 shafts are on the Niagra vein and are 1,000, 2,050, and 1,800 feet deep, respectively. No. 7 shaft is on the Queen of the Hills vein and is 200 feet below the tunnel level.

The length of the ore shoot on the Congress vein varied greatly on different levels. On the 650 level it was stoped continuously for 1,800 feet on the strike. The average thickness of the ore throughout the mine was less than 3 feet. Several pinches occurred along the dip of the vein, the most serious being on the 1,700-foot level, where there was no stoping ground at all. From this level a 1,000-foot winze was sunk at the projected extension of the ore shoot above. The first few hundred feet of this went through lean ground, but after that the ore came in again as rich as ever. The 3,900-foot level was the lowest level at which any considerable amount of ore was mined. There was a gradual pinching of the ore shoot for several levels above. The vein became narrow and irregular although it maintained its general mineralogical character and gold content.

The Niagra vein is entirely in granite, unaccompanied by basic intrusives. It was productive of commercial ore to a depth of 2,000 feet. It dips to the north at 40° to 50° and contains more quartz than the Congress vein.

The all-granite veins are characterized by more galena and higher silver values than the veins that occur in conjunction with basic intrusive dikes.

The production of the mine, by veins, is as follows:

Vein	Tons
Congress	378,992
Niagra	293,215
Queen of the Hills	20,125
Total	692,332

VULTURE AND BIG HORN DISTRICTS

The Vulture and the Big Horn districts are in northern Maricopa County to the south and southwest of Wickenburg. The Vulture district includes the Vulture Mountains just south of Wickenburg and the Big Horn district includes the Big Horn Mountains and the eastern edge of the Harqua Hala Mountains to the southwest of Wickenburg.

The Vulture and the Big Horn Mountains consist in part of andesite and rhyolite flows on a basement of schist and granite. The veins are mostly in granite and near the granite schist contacts. A number of veins in the volcanic andesites and rhyolites have been prospected, but nearly all of the productive mines have been developed on veins in the granite or schist.

Vulture Mine[7]

Topography and Geology

The Vulture mine is in the Vulture mining district in Maricopa County, 14 miles by road southwest of Wickenburg. It is at the southern edge of the Vulture Mountains at an altitude of about 2,000 feet. At the Vulture mine the country is moderately hilly, but farther to the north it becomes more precipitous and rugged.

The vein system is in a fault zone that strikes roughly east and west and dips to the north at about 45°. The footwall of the vein consists of schist, the laminations of which are roughly parallel to the vein in dip and strike. The hanging wall consists of a dike of granite-porphyry about 80 feet wide.

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[7] Wilson, Cunningham, and Butler, work cited. (See footnote 6, p. 157.)

According to descriptions furnished by early observers, the mineralized zone was 80 feet wide and consisted of several veins that ranged in width from 6 to 12 feet and had a total width of 32 feet. The outcrop was very prominent and projected as much as 80 feet above the general level of the adjacent country. This condition favored the open-cut methods of mining that were used extensively by the first operators.

The upper oxidized portions of the vein were characterized by iron oxides that appeared as a stain on the quartz which constituted most of the vein. Some wulfenite was found in the openings of the quartz. Below the oxidized zone the vein minerals, other than quartz, were galena, pyrite, sphalerite, and chalcopyrite. Concentrates ran from $120 to $200 a ton in gold and contained from 12 to 15 percent lead, 8 to 12 percent zinc, and from 1 to 2 percent copper.

History

The property was discovered and staked by Henry Wickenburg and associates late in 1863. During the three years that followed, rich portions of the vein were mined by open-cut methods and treated in an arrastre at the Hassayampa River.

Late in 1866 the Vulture Mining Co. of New York acquired the property and established a camp at the mine and built a 40-stamp amalgamation mill near the present site of Wickenburg. The company operated from 1867 until 1872, during which time approximately $1,850,000 worth of bullion was recovered from ore that ran from $25 to $90 a ton.

From 1872 until 1931 the mine was operated by five different companies. It is estimated that during this time bullion and concentrates worth about $5,000,000 were produced.

In 1927 D. R. Finlayson acquired the property and organized the Vulture Mining and Milling Co. Ore from pillars was treated in a 5-stamp amalgamation mill.

In 1930 and 1931 the United Verde Extension Mining Co. of Jerome became interested in the property and acquired a controlling stock interest in the Vulture Mining and Milling Co. Considerable money was spent in development and diamond drilling. A 500-foot shaft was sunk, and over 1,000 feet of drifting and crosscutting was done in searching for new ore bodies. The results of this work were disappointing and the United Verde Extension Co. withdrew its financial support, although it still retains control of the Vulture Mining and Milling Co.

Since 1931 the property has been worked under lease by D. R. Finlayson and A. B. Peach. Operations consisted of mining pillars and other unmined portions of the vein left by former operators. Mining was mostly by open-cut methods. The ore was first milled in the 10-stamp amalgamation and concentration mill and about 10 tons of concentrates a month were produced. Later, the mill was altered and the capacity was increased so that tailings could be treated along with the mine ore. A cyanide leaching plant was also added to treat an additional 100 tons of tailings a day.

Hardrock mining was discontinued in 1935. The cyanide leaching plant was taken over by D. R. Finlayson and the concentrating plant by A. B. Peach. At present, both plants are operating on tailings.

The tailings from the upper oxidized levels and those from the lower sulphide levels have been segregated roughly by time and accident. Tailings from the first operations were washed by cloudbursts into an arroyo south of the mine. This material is largely from the upper oxidized levels and is being treated in the cyanide leaching plant operated by Finlayson.

Tailings from later operations were disturbed to a less extent and remain very much as they were when originally deposited. Some of this material is highly oxidized and sticky and has been found to be very difficult to treat either by flotation or cyanide leaching. The less oxidized material from the lower levels is easily accessible and is being treated in the flotation plant operated by Peach.

Finlayson Lease

Water supply.- The water supply is from the Mariona shaft, about 1 mile north of the plant. The water is bailed from the shaft a distance of 480 feet with a single-drum hoist operated by a 55-horsepower gasoline engine. The capacity of the bailing bucket is 300 gallons. The entire needs of the plant of 25,000 gallons a day can easily be bailed in an 8-hour shift. The water is discharged from the bailing bucket into a storage tank of 8,000 gallons capacity. From there it is run through a gravity pipe line 4 inches in diameter at the head and 3 inches in diameter at the end to a storage tank of 12,000 gallons capacity located at the plant.

Mining and transportation.- When the leaching plant was first started in 1935, the old tailings had to be hauled only about a quarter of a mile from the head of the arroyo into which it had been washed by cloudbursts. As the deposits in the upper end of the arroyo became depleted, the distance from the source of supply to the plant became greater. In October 1936 this distance was from 1 to 1-1/4 miles.

The loading was done by scraping the material to the top of a ramp with a horse-drawn fresno and dumping it into a truck. The ramp was moved from one place to another whenever necessity required. The material was loaded and delivered to the leaching plant on a contract basis. The price paid was $6 for filling a treatment tank of 50 ton-capacity or 12 cents a ton. The contractors furnished the labor and horses only. The company owned the truck and furnished the fuel, lubricating oil, truck repairs, etc.

In October 1936, the fresno and the ramp were dispensed with and a 3/8-yard power shovel substituted. The principal reason for making the change

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was that too much material was required to make the approaches to the ramp. At the upper end of the arroyo where the deposits were large this objection was not very serious. However, further down where the deposits were thinner, such a large percentage of the available material was required to build approaches that it was considered advisable to change to the power shovel.

The terms of the contract for delivering the material to the leaching plant remain the same under the new set-up, except that the contractors furnish labor only. The truck and the power shovel belong to the lessor, who furnishes gasoline, lubricating oil, and repairs for both.

Two men are required to operate the shovel and the truck in delivering an average of 75 tons of material daily to the leaching plant. The full capacity of the plant is 100 tons a day, but shut-downs bring the average down to about 75 tons a day.

Leaching.- The leaching plant (fig. 15) is on a knoll about 30 feet above the general level of the surrounding country. It consists of 6 treatment tanks, 2 solution tanks, a storage tank, zinc boxes, and pumping equipment for circulating the solution and sluicing out the treatment tanks.

Each treatment tank is 16 feet square, 5 feet 3 inches deep at the back end, and 5 feet 9 inches deep at the front end. The walls are 6 inches thick at the top and 8 inches thick at the bottom. The plant was built in two sections of three tanks each. A mixture of one part concrete, three parts sand and four parts gravel was used without reinforcing. It is said that the tanks cracked at the corners almost as soon as they were filled and the material was made wet for treatment. When the tank is filled, the top is leveled by hand.

A heavy plank floor of 4-inch Oregon fir timber extends about 5 feet over the back end of all of the tanks. This is to facilitate loading the tanks. The loaded truck is backed up to the edge of the floor against a bumper and the load discharged in about the center of the tank.

At the front end of each tank, about 6 inches above the bottom, there are two ports about 1 foot wide by 1-1/2 feet high. These are for flushing out the treated material. After a tank is flushed out the ports are closed with pieces of boiler plate bolted to the outside. The solution is drained from the tanks by a 2-inch pipe at the bottom left-hand corner (looking from front to back) of each tank. This pipe is also used as an outlet for very fine mud that gets through the filter mat of muslin and jute and must be cleaned out whenever the filter mat is replaced. For this purpose, it has not been found entirely satisfactory because it is too small. Mr. Finlayson thinks a 4-inch pipe would be better.

The false bottom (fig. 16) in the tanks consists of 1- by 6-inch flooring bored with 5/8-inch holes and nailed on 2- by 4-inch joists placed at right angles to the slope of the concrete bottom. The joists rest on small blocks of wood about 2 inches thick, to permit the solution to drain to the front end of the tank. Two layers of jute cloth are placed on top of the flooring

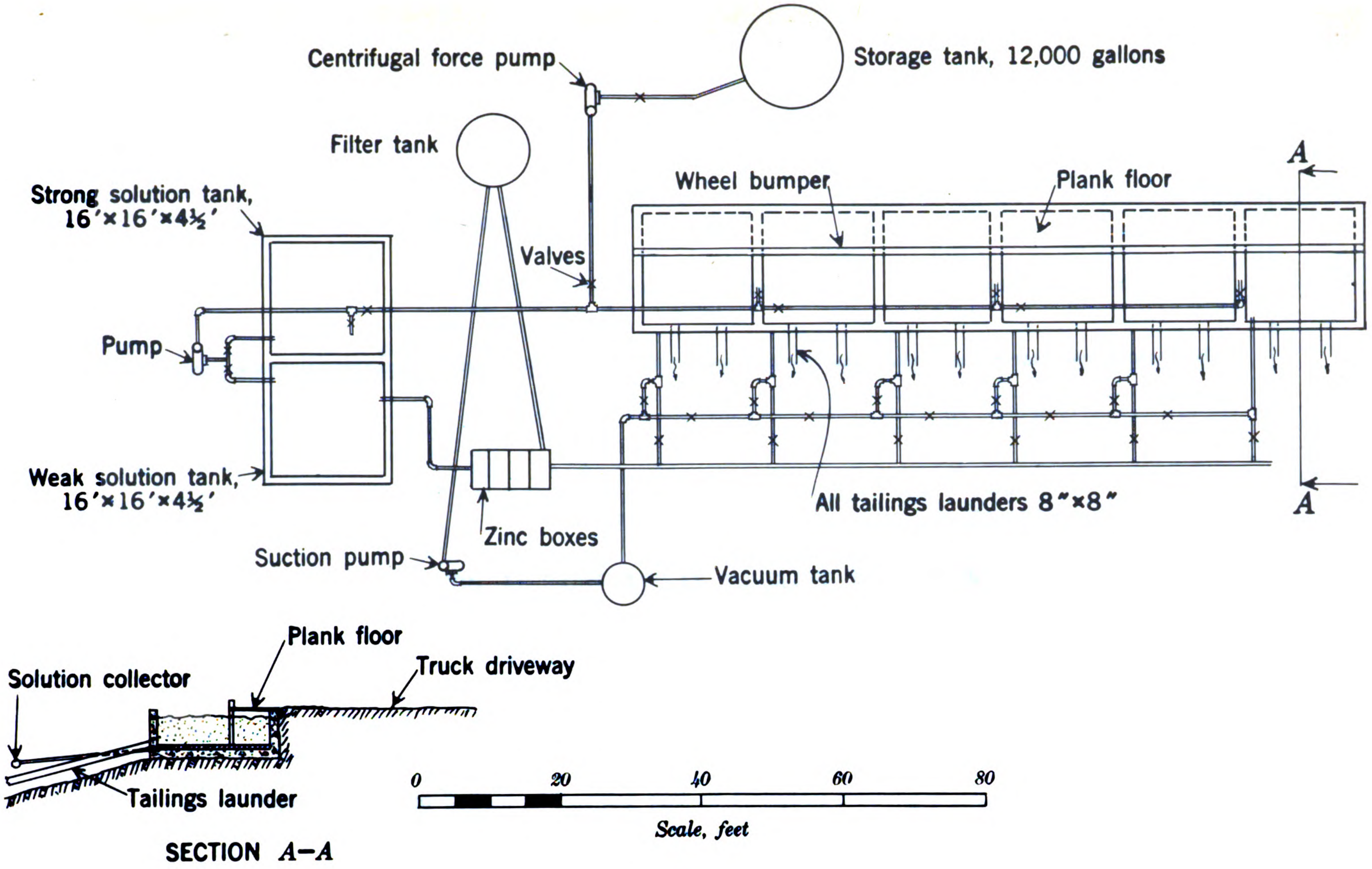

Figure 15.—Plan of Finlayson leaching plant, Vulture, Ariz. Maximum capacity 100 tons a day.

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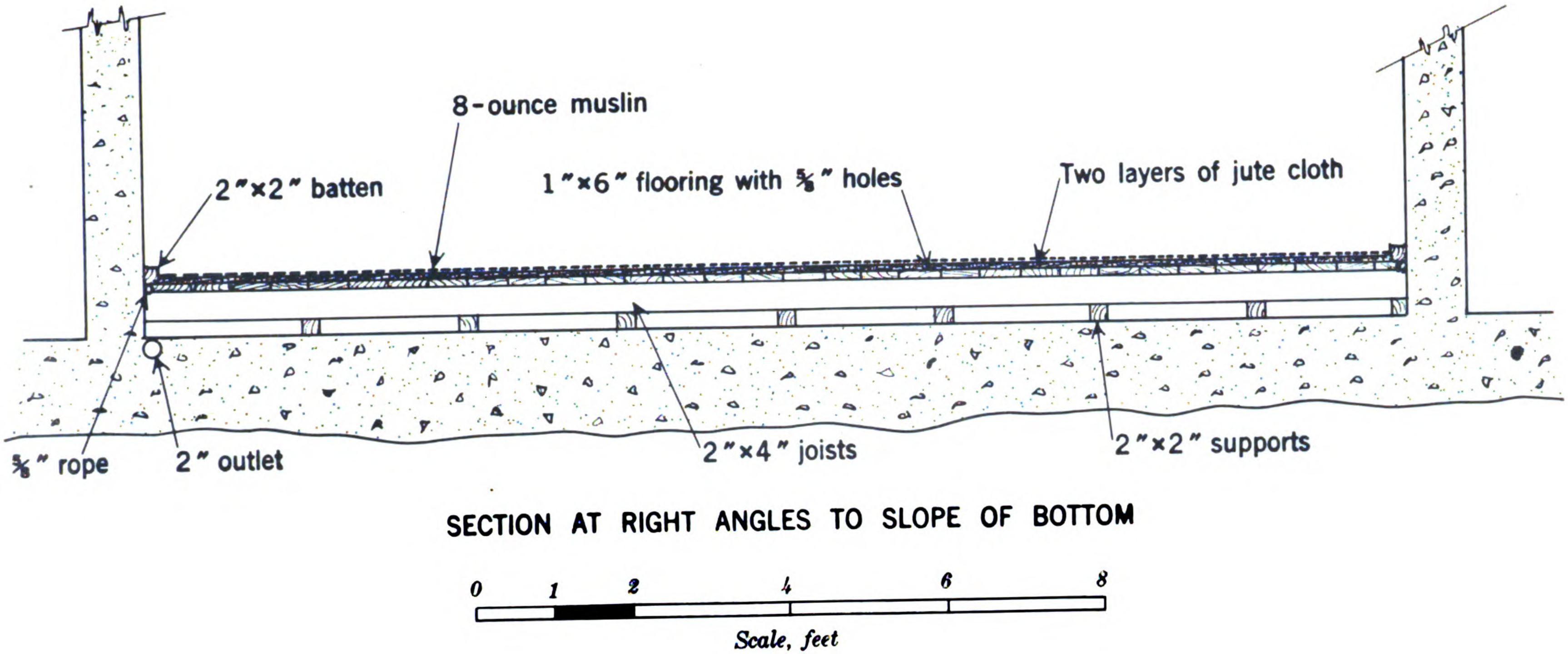

Figure 16.—False bottom of leaching tank of Finlayson leaching plant, Vulture, Ariz.

and a good grade of 8-ounce muslin on top of this. The muslin is cut about 6 inches oversize on all four sides, and the edges are corded down between the concrete walls and the floor with a 5/8-inch rope. The cording is held in place by 2- by 2-inch battens nailed to the flooring.

The solution tanks are of concrete construction similar to the treatment tanks. They are 16 by 16 feet square and 54 inches deep and hold 36 tons of water each. One is in open circuit with the zinc boxes while the other is used to store strong solution for treating the ore. A gasoline pump is connected so that solution can be pumped from either tank to the treatment tanks or from the one in open circuit with the zinc boxes to the one in which the strong solution is stored. Cyanide is added ordinarily to the tank in open circuit with the zinc boxes, which is normally the weak-solution tank. After cyanide has been added, the solution is pumped into the strong-solution storage tank, where lime is added.

A suction pump is used for material that is sticky and slimy and slightly impervious to the solution. It is connected to the outlet of each treatment tank and can be used on all tanks simultaneously or for any one alone. There is a vacuum tank between the pump and the main suction line to provide a constant vacuum. The solution is pumped to a solution tank with a canvas bottom, where it is filtered before it goes to the zinc boxes. It is stated that it will pull a vacuum of 16 to 18 inches of water when all tanks are connected. So far, no material was treated that required more than a 5-inch vacuum. The cycle of operation in the leaching process is as follows:

		Hours
1.	Tank is loaded with 50 tons of dry pulp.	
2.	Covered with 18 tons of strong cyanide solution, 2 hours required to cover and 2 hours to saturate, total................	4
3.	Tapped into circuit and permitted to drain for..................................	10
4.	Left to dry and aerate (aeration period)...	8
5.	Covered with weak solution from zinc boxes. As soon as this is out of sight, it is covered with wash water[8] from the storage tank. Weak-solution wash requires about 14 hours and the fresh-water wash about 36 hours, total..........................	50
	Total time for treatment...............	72

[8] This is where fresh water is added to the circuit.

It is said that the aeration period is very important and has an appreciable effect upon recovery.

After the wash water works for a while, the solution is tested for cyanide. When the strength is down to 0.4 pound per ton, the tank is cut out of the circuit and sluiced out. It has been found that the gold in the solution is a function of the cyanide content, and when this is down to 0.4 pound per ton, the solution is practically free of gold.

Solutions and reagents.– The solution for the initial treatment is made up to a strength of 2 to 2-1/2 pounds of cyanide and 1 to 1-1/2 pounds of lime per ton of water. The solution in the weak-solution tank is first tested for cyanide strength and then enough cyanide is added to bring it up to standard strength. After the solution is pumped into the strong-solution tank, it is tested for alkalinity and lime is added accordingly.

The zinc shavings used in the zinc boxes are dipped in lead acetate to keep them from becoming plated with copper.

Tailings disposal.– The treated pulp is sluiced through the ports with a jet of water from a high-pressure nozzle. Pressure is furnished by a high-pressure centrifugal pump, belt-connected to an old automobile engine. The water is taken direct from the 12,000-gallon storage tank at the plant. The job of sluicing out a tank of the treated pulp requires from 8,000 to 10,000 gallons of water and the labor of one man for an hour to an hour and a half.

The spent pulp goes from the ports of the treatment tanks to the tailings pond, through open wooden launders about 8 by 8 inches in cross section and placed at a grade of 5 to 7 percent. The tailings pond is about 400 feet from the plant.

Express and smelting.– The precipitates usually run about $15 a pound. They are shipped by express to the plant of the American Smelting and Refining Co. at Selby, Calif. Gold is paid for at the rate of $33.528665 per ounce and silver at the rate of 76 cents per ounce. There is a sampling and assaying charge of $10 and a reduction charge of $5 for each shipment.

The following is a settlement statement of a small shipment that was made in October 1936:

Weight of precipitates	96 pounds	
Assays:		
Gold – 415.40 ounces per ton at	$33.528665	$13,927.81
Silver – 795.85 ounces per ton at 0.77 – 1 or 0.76		574.60
Total value per ton		14,502.41
Value of 96 pounds at $14,502.41 per ton		696.12
Deductions:		
Assaying and sampling	$10.00	
Reducing	5.00	
Express	5.88	
Total	20.88	20.88
Net proceeds –		675.24
To be paid upon receipt of properly executed affidavit which will permit the silver content to be sold to Government		11.70
		663.54

Labor and supplies.- The labor required to operate the plant is as follows:

Mining, 2 men on contract	@	$4.50	1/ $9.00
Plant operators, 1	@	4.50	4.50
Plant operators, 2	@	4.00	8.00
Pumpmen, 1	@	4.00	4.00
Total			25.50

1/ Average for a normal month.

Gasoline consumption is as follows:

	Gallons per day
Truck	12
Water bailing	18
Plant	12
Power shovel	12

Standard grade gasoline is delivered at the plant for 18 cents a gallon, including tax. There is a rebate of 5 cents a gallon on all except that used in the truck.

Metallurgical data.- The following shows the average values in the heads and tails and the values recovered in the precipitates:

Gold in heads, per ton	0.050 ounce	@	$33.53	$1.67
Silver in heads, per ton	.100 ounce	@	.76	.08
Total				1.75
Gold in tails, per ton	.005 ounce	@	33.53	0.17
Silver in tails, per ton	.010 ounce	@	.76	.01
Total				.18
Gold recovered in precipitates, per ton	.045 ounce	@	33.53	1.50
Silver recovered in precipitates, per ton	.090 ounce	@	.76	.07
Total				1.57

Recovery, gold . . . . 90 percent
Recovery, silver . . . . 90 percent

Costs.- The costs shown here represent the average operating expenses for a month of normal operations. These costs do not include plant depreciation and royalties.

Tons of ore treated, 45 tanks of 50 tons each . . . . 2,250 tons.

Labor:			
Mining and delivery to plant	$270.00	$0.120	per ton
Labor at plant and water supply system	495.00	.220	do.
Assaying	90.00	.040	do.
Compensation ($4.38 per $100)	37.50	.017	do.
Total labor	892.50	.397	
Supplies:			
Gasoline	237.00	.105	
Lubricating oil	10.00	.004	
Cyanide	140.00	.062	
Lime	64.00	.028	
Precipitating reagents (zinc shavings and lead acetate)	41.80	.019	
Total supplies	492.80	.218	
General expenses:			
Hauling supplies	15.00	.007	
Express, assaying, refining, etc.[9]	42.00	.018	
Total general expenses	57.00	.025	
Total operating	1,442.30	.640	

[9] Does not include $1.47 ounce discount on gold at smelter.

Peach Lease

Water supply.- Water is pumped from a 700-foot drilled well lined with 5-inch casing and about a half mile from the mill. The pump was built from a gear, a pinion, an old engine frame, and some other miscellaneous junk that was picked up in Jerome. It is operated by a 30-horsepower Diesel engine and delivers from 70,000 to 80,000 gallons of water every 24 hours when it works.

Two hundred feet of 1-1/2-inch double-strength pipe and 500 feet of 2-inch wooden shafting are used for pump rods. A great deal of trouble has been experienced because of breakage of the pipe at the sleeves. Whenever this happens the mill must be shut down from one to two days while the pump rods and plunger are being pulled and repaired. A special fishing tool was made for catching the end of the broken rod and the pulling is done with a heavy block and a caterpillar tractor. There is some breakage of the wooden shafts, but on the whole they give more satisfactory service than the double-strength pipe. One and one-fourth-inch diamond drill rods were tried, but they were less satisfactory than the 1-1/2-inch double-strength pipe.

There is a storage tank of 5,000-gallon capacity at the well and one of 50,000-gallon capacity at the mill. A centrifugal pump run from a countershaft from the main pumping engine lifts the water from the tank at the well to the tank at the mill. The water runs by gravity from the second tank into the mill.

Mining.- The tailings are delivered to the mill bin by contract for 20 cents a ton. The contractor furnishes all of the labor, material, and equipment required.

The material is loaded into a truck by a 3/4-yard gasoline shovel, which excavates from a bank from 10 to 12 feet high. The distance to the mill is about 1/4 mile. The truck hauls 5-ton loads. The shovel uses about 30 gallons of gasoline per day and the truck about 10 gallons.

Two men working a split shift furnish all of the labor. One man operates the shovel and drives the truck and the other breaks up the clods and works the material through a grizzly with openings of 5 to 6 inches. A split shift is necessary because the mill bin holds only 75 tons. The work is arranged so as to do as much as possible in the daytime, but the men are subject to call whenever the bin becomes empty.

The bin can be filled in from 2-1/2 to 3 hours while the mill is running. From 8 to 9 hours, or the equivalent of about one shift, is required to supply the 250 to 300 tons a day required by the mill. The truck driver and shovel operator receive $150 a month. The man who works at the bin is paid on a contract basis and makes from $4.50 to $5.00 a day.

The tailings deposit has an average depth of 20 to 25 feet. The upper 10 to 12 feet is from the lower sulphide levels and runs from $2.75 to $3.00 a ton. From 75,000 to 80,000 tons of this material was mined and milled since November 1935. From 65,000 to 75,000 tons remain, or enough to keep the mill going for about 10 months.

The lower part of the deposit consists of a red sticky oxidized material which is said to run $1.80 a ton. It is stated that there is 180,000 tons of this material and that it cannot be treated successfully by flotation. Finlayson states that he tried treating it in the cyanide leaching plant, but it is so sticky that the solution would not percolate through it.

Milling.- The original mill consisted of 10 stamps, some amalgamation plates, and concentrating tables. In 1933 it was remodeled by building a new bin and installing a jaw crusher and a Symons cone crusher. The stamps were removed and a 4- by 8-foot rod mill substituted.

By November 1935 hard-rock mining had been discontinued entirely and the mill was remodeled for treating tailings only. A flotation unit was installed and the crushers, tables, and amalgamation plates were removed.

At present the mill consists of an ore bin of 75-ton capacity, a rod mill, 6 pneumatic flotation cells, and a dewatering and drying plant on the outside. It is operated at a capacity of 250 to 300 tons a day.

Grinding.- The ore is taken from the bin to the rod mill by a belt feeder about 8 feet long. The rod mill is operated at a speed of 30 to 35 r.p.m. Rod and liner wear are very small because of the nature of the material and

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the large tonnage that is crowded through. It appears that the liners had not been replaced since the mill started operating on tailings in November 1935. Rod wear is probably less than 1/2 pound per ton of ore milled.

Grinding is very inefficient. The mill does little more than break up large clods that cannot be handled in the flotation cells.

Flotation concentration.- The discharge from the ball mill is run direct to six pneumatic flotation cells. Finished concentrates are taken from each cell and the tails are run to the tailings pond.

Reagent No. 301 is added at the ball-mill feed at the rate of 0.2 pound per ton of ore, and pine oil is added at the head of the flotation cells at the rate of 0.1 pound per ton.

About one ton of water is used for every ton of ore milled, including about 20 percent that is pumped back from the tailings pond.

Typical head, tail, and concentrate assays are as follows:

Heads	.09	ounce gold
Concentrates	1.6	ounces gold, 5 ounces silver, 2 percent copper
Tails	.05	ounce gold

Ratio of concentration = 36.1 to 1
Extraction - gold 44.4 percent.

Low extraction is due to inefficient grinding as well as to the lack of classifier and rougher cells. Jack Garvin, the mill superintendent, states that the large amounts of lime that were used in former milling operations have made the problem more difficult.

Much of the material has been recemented by iron oxide. This is not completely broken up by the ball mill. A great deal of it can be seen when panning the flotation tails. It consists of fine sand in small clods from 1/15 inch to 1/20 inch in diameter. According to Garvin, these clods contain considerable values that cannot be saved because the particles are too large.

Dewatering and drying.- The concentrates are run from the flotation cells to a shallow wooden tank about 3 feet deep by 10 feet wide by 20 feet long. This tank does not furnish sufficient settling area for all the concentrates. Settling is completed partly on the drying floor and partly in shallow concrete pools.

The dewatered concentrates are shoveled from the tank and from the concrete pools onto a wood drying floor, where they are dried by the sun. During the dry summer season it is possible to get the moisture content down to 6 percent, but during the rainy seasons and in winter it is difficult to get it below 8 to 10 percent.

Freight and smelter.- The concentrates are trucked a distance of 115 miles to the United Verde Extension smelter at Clemenceau, Ariz. The trucking rate $4.75 a ton and the treatment charges $5.00 a ton. Metals are paid for according to the following schedule: Gold, $33.50 per ounce for 95 percent; silver, 77 cents per ounce for 90 percent, copper, deduct 8 pounds per ton when less than 5 percent and pay 7.025 cents per pound (copper quoted at 9.56 cents per pound) for the rest.

Labor.- The mill payroll for three shifts is as follows:

1 operator and foreman	@	$6.00	$6.00
2 operators	@	4.50	9.00
7 helpers	@	3.50	24.50
1 mechanic	@	5.00	5.00
1 assayer	@	3.00	3.00
Total			47.50

The helpers see to the drying of the concentrates and do any other manual labor required about the mill. The mechanic takes care of pumps and powerhouse machinery as well as the mill equipment. The mill operators take care of the power plant, which is housed in the same building as the mill.

One regular pumpman is paid $9.50 a day to take care of the water supply. He sleeps at the well and is on duty 24 hours a day. The assayer does the assaying for both the Peach lease and the Finlayson lease, and also the timekeeping and bookkeeping for the Peach lease.

Power.- Power is furnished by a 55-horsepower single-cylinder Diesel engine. It is connected to the ball mill, flotation cells, and blower by a line shaft and belts. A small generator for lighting is also run from the line shaft.

Fuel-oil consumption is from 35 to 40 gallons per 24 hours, and lubricating-oil consumption about 1 gallon per 24 hours. The total operating cost, exclusive of labor, is about $4 per 24 hours.

Costs.- The following approximate costs for September 1936 were made from information furnished by the mill superintendent and the assayer:

Total tons milled, September 1936 = 7,200.

		Per ton	
Mining:			
Delivery according to contract			$0.200
Milling:			
Labor	$1,425.00	$0.198	
Compensation and insurance	62.42	.009	
Reagents	490.00	.068	
Power (fuel and lubricating oil)	120.00	.017	
Total milling	2,097.42		.292
Water supply:			
Labor	285.00	.040	
Compensation and insurance	12.50	.002	
Fuel and lubricating oil for main pump	90.00	.0125	
Gasoline for starting engine	45.00	.0062	
Gasoline for pump at tailings pond	45.00	.0063	
Total water supply	477.50		.067
Total operating costs	2,574.92		.559

It is said that on account of shut downs and high labor costs for repairing the frequent pump-rod breakage at the well, the water costs are about the same as the milling costs. According to this, 22 cents would have to be added to the water-supply costs, making the total operating costs 78 cents a ton.

Freight and smelter costs, based on a ratio of concentration of 36 to 1, disregarding discounts on price of metals.

Total tons concentrates = $\frac{7,200}{36}$ = 200.

Freight, 200 x $4.75 = $950.00, or $0.132 per ton.
Treatment, 200 x $5.00 = $1,000.00 or $0.139 per ton.
Total marketing = $1,950.00, or $0.271 per ton.
Total operating and marketing, $1.05 per ton.

Sunrise Mine

Situation

The Sunrise mine is in the Vulture mining district, 2-1/2 miles south of the village of Aguila, on the Santa Fe railroad. There are seven unpatente claims owned by the Sunrise Mining Co. and held under bond and lease by the Palo Verde Mining Co., C. W. Mitchell, president, Wickenburg.

Geology

The country rock is granite and schist. The vein is in a band of schist and bears approximately east and west and dips to the north at 35° to 40°. The mineralization consists of free gold in limonite and hematite. There are a great many open cuts on all parts of the property, from which ore can be taken that will pan free gold.

Development

Development consists of two incline shafts, one 330 feet deep on the dip of the vein and one 200 feet deep on the dip of the vein. The shafts are about 400 feet apart and are connected by a drift on the 200-foot level. There are six levels at intervals of 50 to 60 feet, 1,000 feet of drifting and crosscutting, and 500 feet of raising.

An ore shoot on the 200-foot level runs from $8 to $12 a ton in gold, is 160 feet long, and ranges in width from 2 to 4 feet. The same ore shoot is opened on the 330-foot level for a distance of 135 feet, with both drift faces still in ore.

Production

During 1934, 800 tons of ore were shipped to the smelter and 400 tons were milled in a small amalgamation plant in Wickenburg. The average value of the ore milled was $20 a ton, but the milling venture was not successful. Data are available covering only 570 of the 800 tons that were sent to the smelter. This 570 tons was produced from February 21, 1934, to May 17, 1934, and was shipped to the El Paso plant of the American Smelting and Refining Co. The highest grade was $33.95 a ton and the lowest $13.51 a ton. The gross value was $12,330, or $21.70 a ton, and the net value $6,438, or $11.10 a ton. Smelter and freight rates per ton of ore were as follows:

Smelter base,	$3.70	+ $0.49 for copper deficiency.
Freight,	5.70	
Trucking,	1.00	
Total	10.40	+ .49

Gold was paid for at $32.32 per ounce.

Mining Methods

No systematic mining method has been developed. The ore was mined from low overhead open stopes that were not high enough to present any difficulty. The ore was shot from the back and shoveled from the floor of the drift. Very few stulls were required to hold up the hanging wall, but if mining is every very extensive, more timber or back filling will have to be used. The vein is not steep enough for the ore to run, and when the stopes get high, the ore will have to be either shoveled by hand or moved mechanically. The costs, including development, were $6 a ton for all of the ore produced.

Labor

The mine has been idle since 1934. Never more than from 10 to 15 men were employed, and these were mostly underground. Miners were paid $4 a day and common laborers $3.25 a day, with $1 a day deducted for board and lodging.

Equipment

Equipment consists of a 25-horsepower gasoline hoist, a compressor of 110 cubic feet capacity, a small jaw crusher operated by an 8-horsepower gasoline engine, an ore bin of 35 to 40 tons capacity, and several rock drills.

The nearest commercial power is at Wickenburg, 25 miles to the east.

Pump Mine

Situation

The Pump mine is in the Big Horn mining district 14 miles due south of the village of Aguila, the nearest railroad shipping point. The property consists of 17 claims held by location. Nine of the claims belong to the Fortunate Fields Mining Co., which is operating the property, and eight are leased from T. B. Atkins of Aguila. Bailey Grigsby, of Phoenix, is the president of the company.

Topography and Geology

The property is in a comparatively level country with a few low ridges of schist and granite. The elevation at the collar of the shaft is about 2,800 feet. The vein bears approximately east and west and dips to the north at about 46°. The country rock is granite with bands of schist running approximately parallel with the vein. The ore in the upper levels has been oxidized to a considerable extent, although it contains some gold-bearing sulphide minerals. The ore in the lower levels is oxidized very little and the gold is associated almost entirely with sulphides of iron, copper, lead, and zinc.

Water Supply

The water supply is from a well 10 inches in diameter and 500 feet deep. The collar of the well is 360 feet below the mine and a distance of 4-1/2 miles to the northwest. The water is pumped into storage tanks at the well by a 15-horsepower gasoline pump. From the storage tanks at the well to the storage tanks at the mine it is pumped through a 4-inch welded pipe line by a triplex pump powered by a 25-horsepower gasoline engine.

At the well is storage capacity of 25,000 gallons, consisting of two concrete tanks of 12,500 gallons capacity each. At the mine is a storage capacity of 36,500 gallons, consisting of two concrete tanks of 12,500 gallons capacity each and two of 5,750 gallons capacity each.

The floors of the tanks are 8 inches thick and were made from a mixture of seven parts of sand to one part of cement. The walls are 6 inches thick and were made from a mixture of six parts of sand to one part of cement. Silo forms were used for pouring the concrete, and the floors and walls were reinforced with 1/2-inch steel.

The large tanks cost $147 each and the small ones $83 each. These costs include all labor and material.

Development

Development consists of an inclined shaft 320 feet deep on the dip of the vein, with three main levels at approximately 100-foot intervals and an intermediate level about half-way between the first and second. There is 40 feet of drifting on the first level, 160 feet on the second, 50 feet on the third, and 170 feet on the intermediate. The vein has been prospected for 4,000 feet on the surface by a number of shafts, the deepest of which is 125 feet on the dip of the vein, and a great number of open cuts.

Mining

Up to November 1936 very little systematic mining had been done. The mine and mill had been in operation for only about a month and most of the ore milled was from development work.

Mining is by the open-stope overhead method. Raises are run every 75 feet and chutes are installed every 25 feet. The raises are about 4 by 6 feet in section and are generally connected with the level above before stoping starts. The vein is steep enough so that the ore runs by gravity. Round stulls are used in the stopes for holding up the hanging wall wherever necessary. The chutes are built from Oregon fir timber.

Self-rotating stoping machines with 1-inch hexagon steel are used in the stopes and raises. Mounted jackhammers with 7/8-inch hexagon steel are used in the drifts.

Detachable bits are used with all machines. Careful measurements taken over a considerable period of time and in all parts of the mine indicate that a bit drills 15.75 feet. It is said that the saving over hand- or machine-sharpened steel amounts to $8 a day in labor and material, besides eliminating a considerable capital investment for steel shanks. The expense incurred through threads on the shank wearing out is negligible. Bits are used until they are dull and then are discarded.

The ore is hoisted in a 1-ton skip and dumped from the top of the headframe into a mill bin of 85 tons capacity. The waste is dumped into a waste bin about half way between the collar of the shaft and the top of the headframe. Dumping into the waste bin is effected by spreading the rails of the main track about 4 inches. This permits the front wheels to run on the lower rails while the back wheels run on the rails of the main track. The spreading of the rails is done from the bottom of the headframe by means of a lever arrangement.

The mine payroll consists of:

			Per day
3 miners	@	$4.25	$12.75
3 muckers	@	3.50	10.50
1 hoistman	@	4.00	4.00
Total			27.25

The mill payroll, including water, is:

2 operators	@	4.50	9.00
2 helpers	@	4.00	8.00
1 engineer	@	4.50	4.50
1 crusherman	@	3.50	3.50
1 pumpman	@	3.50	3.50
Total			28.50

Quarters are furnished free, but $1.25 a day is deducted for board.

Milling

The mill has a capacity of 50 tons a day. It consists of ten 1,250-pound stamps, two amalgam plates, and two Deister tables. The stamps drop 6-1/2 inches and 94 times per minute. The plates are 48 inches wide and 54 inches long.

The ore runs from the 85-ton bin through small chutes and into the stamp batteries. Mercury is added at the stamps according to the grade of the ore. Each battery of five stamps is in open circuit with an amalgam plate and a Deister table. The amalgam is melted at the mill and the bullion shipped to the mint in San Francisco.

Milling operations were begun in September 1936. During January 1937 stoping was started on the deeper levels, where the ore consists almost entirely of gold-bearing sulphides. Recovery dropped so low that it was considered advisable to stop operating until a new flow sheet could be worked out and new machinery installed.

During the 5 months that the mill operated, the heads ran about $12 a ton, and it is estimated that total recovery was 90 percent. About 75 percent of the recovery was from the amalgam plates and 25 percent from the tables. The table concentrates ran from $80 to $100 a ton in gold.

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A screen analysis of the stamp discharge showed 100 percent of the material to be minus-40 mesh and 54 percent minus-200 mesh. Water was consumed at the rate of 3 tons per ton of ore when no water was reclaimed. When water was reclaimed from the tailings pond, the consumption was 1.6 tons per ton of ore.

Metallurgical and cost data are not available.

The mill is powered by a 60-horsepower gasoline engine, which is belt-connected to all units by means of countershafts. A compressor of 173 cubic feet capacity also is operated by the engine from a countershaft. In the 5 months during which the mill operated, the compressor was run on day shift only. On night shift the mill operator took care of the engine, but on day shift an extra man was required to take care of the engine and compressor.

Prospects in the Big Horn and Vulture Districts

South Vulture

The South Vulture property is about a mile south of the original Vulture mine. It consists of 10 unpatented claims owned by Mrs. Seidletz of Wickenburg and held under lease and option by the South Vulture Mining Co. Chas. S. Flursheim, of Los Angeles, is the president of the company and is furnishing all the money.

The claims cover a low ridge about 3/4 mile long by 1/4 mile wide and about 150 feet higher than the surrounding plane. The ridge probably is a dike of volcanic eruptives. The most conspicuous rock is a white porphyrytic material very low in density and resembling pumice or scoria.

Development consists of a 1-compartment shaft 120 feet deep timbered with 8- by 8-inch Oregon fir. There are several short adits and small open-cuts that were made by early prospectors, but none of these show much evidence of mineralization.

The shaft is entirely in the white porphyrytic material that is so common at the surface. It is said there is a vein about 10 feet in from the footwall side of the shaft, but there is little or no evidence of it on the surface.

Equipment consists of a small gasoline hoist, a gasoline compressor of 190 cubic feet capacity, and several rock drills. A boarding house and an office had been built recently at the base of the ridge just below the collar of the shaft, and a blacksmith shop and hoist house were in the course of construction. Water for drilling purposes was hauled from the Vulture mine.

In November 1936, 8 men were employed at building and road construction and 4 were working in the shaft.

Red Cloud

The Red Cloud property, consisting of several unpatented claims, is in the Vulture Mountains about 3 miles north of the town of Vulture. The property belongs to the Red Cloud Mining Co., Hugh Steadman, president, Torrence, Calif. The financing is done by a group of California business men who put up from $15 to $25 a month each.

The country rock consists of andesite and similar volcanic rocks. The vein bears approximately N. 30° E. and is nearly vertical. It varies in width from 4 to 6 feet and appears to be considerably oxidized at a depth of 200 feet, although some iron pyrite is visible. It is said that several samples from the 200-foot level ran as high as $6 to $8 a ton in gold and silver, but in no place in the mine is there enough material of this grade to constitute a commercial ore body, or even make enough for a small shipment.

Development consists of a vertical 2-compartment shaft 300 feet deep, with levels at 85, 200 and 300 feet from the collar. The shaft is timbered with 6- by 6-inch Oregon fir. There is from 75 to 85 feet of drifting on eac of the two upper levels and 185 feet of drifting and 120 feet of crosscutting on the 300-foot level.

During the latter part of October 1936 five men were employed in driving the north drift heading of the 200-foot level. Two of these were working underground in the drift heading and three on the surface. Early in November the work was discontinued because of lack of capital. It was planned to resume work as soon as the company could be refinanced.

Equipment consists of a gasoline compressor, a gasoline blower, a gasoli hoist, a hoist and compressor house, a headframe, and several rock drills. The shaft timbering, the headframe, and the hoist and compressor house show a grade of workmanship and a state of maintenance that is rather unusual for a prospect of this kind.

Banker Group of Claims

The Banker group of six unpatented claims is about 11 miles south of Wickenburg and about 1/2 mile east of the Vulture Wickenburg highway. The property is owned by J. B. Price of Wickenburg.

The country rock is granite cut by a series of light-colored porphyry dikes bearing roughly N. 45° W. The vein bears about N. 75° W. and dips about 70° to the north. It cuts across the dikes without interruption and can be traced on the surface for nearly 4,000 feet. At places where it has been exposed by open-cut pits it shows widths ranging from 6 to 12 feet. Quartz is very common and constitutes a major portion of the vein at all places where it is exposed. The most common minerals other than quartz are oxides of iron and manganese, which occupy the fracture planes in the quartz.

The principal development is a shaft about 5 by 8 feet in cross section and 35 feet deep on the dip of the vein. At the bottom of the shaft, a crosscut round was shot into the hanging wall, exposing 8 feet of vein. The hanging wall of the vein, however, had not been reached.

Channel samples cut in the shaft showed the following results:

Location	Width	Gold	Value
6 feet below collar	2 feet of quartz	0.08	$2.80
12 feet below collar	3 feet of quartz	.04	1.40
2 feet above bottom	4 feet of quartz (foot wall)	.08	2.80
2 feet above bottom	4 feet of quartz (hanging wall)	.08	2.80

There is no equipment, and in November 1936 the property was idle.

Cora

The Cora mine is 11 miles from Wickenburg and about 1/4 mile north of the Blythe Wickenburg highway. There are four unpatented claims owned by J. R. Oneal and C. H. Oneal, of Wickenburg, and Thomas Barett, of Phoenix, all of whom share equally.

The country rock is granite and schist. There are several veins in the schist formation. The main vein bears approximately east and west and dips to the south at about 25°. It is from 1/2 foot to 2-1/2 feet thick and consists essentially of quartz with considerable amounts of iron and manganese oxides.

The main shaft is about 100 feet deep on the dip of the vein and has about 15 feet of drifting to the east from the bottom.

The vein has been prospected at a number of other places on the property by a shallow shaft and open-cut pits.

There is no equipment of any kind on the property. All work was done by hand and much of the ore and waste was carried out of the shafts in sacks on the backs of men; because of the lack of equipment, only a limited amount of work was done during the past two years.

During 1935 two shipments of ore were made. One shipment of 8-1/2 tons ran 0.56 ounce gold and one of 6 tons ran 0.62 ounce gold. The property appears to have possibilities of being developed into a producer of 5 to 10 tons of shipping ore per day. It is idle at present.

Golden Rainbow

The Golden Rainbow consists of eight unpatented claims 15 miles east of Wickenburg and 2-1/2 miles south of Forepaugh, a loading station on the Santa Fe railroad. The claims are owned by V. A. Brundage of Wickenburg.

The country rock is granite cut by diorite dikes. The vein bears N. 70° E. and dips to the south at about 20°. It consists of about 1 foot of quartz in the footwall of a diorite dike several feet thick.

Development consists of two shafts, one 50 feet deep and the other 57 feet deep. The 50-foot shaft is entirely on the vein and dips to the south at about 20°. The first 26 feet of the other shaft is vertical and is in waste from the collar to where it intersects the vein. From this point it is on the vein for 31 feet to the bottom. The two shafts lack about 8 feet of being connected at the bottom of the 50-foot shaft and the 26-foot level of the other.

The property has been idle for several years. Sometime previous to 1933 a shipment of 26 tons of ore netted $11 a ton at the $20 rate for gold.

EUREKA DISTRICT

The Eureka district is in southwestern Yavapai County. It is bounded by the Santa Maria River on the south, Burro Creek on the northwest, the Mohave County line on the west, and the Santa Fe Railway on the east. Hillside is the shipping point for the mines in the northern part of the district and Congress Junction for those in the southern part.

The McCloud Mountains to the west and northwest of Hillside attain a maximum altitude of 4,900 feet. The country to the west of these mountains is cut by deep canyons made by the Santa Maria River and its tributaries, Burro, Boulder, Yavapai, and Bridle Creeks.

The country rocks consist mostly of granite, gneiss, and schist intruded by dikes and overlain in many places by mica-forming lavas.

Water Supply

The district is blessed with a more plentiful water supply than its sister districts to the south. Aside from the larger streams, water is obtained from springs and shallow wells. Some of the operating mines make enough water for conducting extensive milling operations without reclaiming any.

Hillside Mine

Situation

The Hillside mine is in the Eureka district on the east side of Boulder Creek, 32 miles by road from Hillside, the nearest railroad station; the elevation is 4,200 feet. The property consists of one unpatented and six patented claims.

Topography and Geology

The country rock is mica schist intruded by granite, with narrow pegmatite dikes. The vein is in the schist and strikes N. 15° E. and dips to the west at about 80°. The schistosity of the rock is practically horizontal in the vicinity of the vein. The width of the vein varies from a few inches up to several feet, with an average of about 1-1/2 feet. It consists of massive gray quartz with abundant sulphides of iron and lead and to a smaller extent zinc. The schist wall rock is very soft and heavy. Back filling is required in all of the stopes, and all development headings must be timbered almost as soon as they are opened.

History[10]

The property was located by John Lawler in 1887. From 1887 until 1892 Lawler did about 7,000 feet of development work, built an 84-mile road to Seligman, erected a small stamp mill, and brought the property into production.

In 1892 the property was sold to H. A. Warner, who organized the Seven Stars Gold Mining Co. This company did further development work, erected a new mill, and built a road to Hillside. In 1892 the Warner company failed, and after considerable litigation the property reverted to Lawler. From 1894 until Lawler's death, in 1917, the property was operated only intermittently and mostly by lessees. In 1917 operations ceased entirely and the property remained idle until 1934, when it was purchased by H. S. Williams, the present owner and operator.

From 1887 until 1917 the production of the property was 13,094 tons of ore, from which was extracted 9,329 ounces of gold and 219,918 ounces of silver worth, in all, $296,500, or $22.65 a ton. Since 1934 production has been over a million dollars.

Development

The mine is developed through two adits and a 2-1/2-compartment vertical shaft 400 feet deep, with five levels. Nearly all development, down to and including the fourth level (second in the shaft), was done by former operators. The development below this level, including sinking of the shaft, was done by the present operators. There is about 2,000 feet of drifting on the fifth level, and 1,100 feet of drifting on the sixth. The seventh level was just being started in November 1936. Including the old workings, there is a total of over 13,000 feet of drifting scattered over approximately 2,400 feet of veins.

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[10] Wilson, Cunningham, and Butler, work cited, pp. 24-25.

Mining Methods

Mining is by the horizontal cut-and-fill method. The ground is extremely heavy and the greatest precaution is taken to prevent caving. Stoping is done in 50-foot sections taken alternately along the vein. The object of this practice is to confine the squeezing effect of the walls to as small a section as possible. This can be controlled without much difficulty if the stopes are not more than 50 feet long.

The drifts are timbered with 8- by 8-inch drift sets at 5-foot centers and lagged with 2-inch plank. When a stope is started, the top lagging and some of the footwall lagging are removed from the sets where chutes and manways are to be installed. Manways are erected at 50-foot intervals and chutes are 15 to 20 feet apart. Mining is started from the top of the drift timbering as soon as the chutes are completed.

The ore passes and the manways are cribbed with 2-inch plank. This cribbing is framed to standard sizes in the saw mill at the surface and distributed underground as it is needed. An ore pass is generally carried along with each of the manways, the two being built as a unit with a partition between.

As soon as the first cut is completed, a raise is started from the back of the stope about midway between the manways. This is run through to the level above as quickly as possible in order to provide an opening for running fill into the stope. Stoping operations are very seldom delayed, however, on account of the raises not being finished, as the waste from the raise, together with what is sorted from the ore, is enough to keep the stope filled until the raise is completed. The stopes are always kept filled to within 6 or 7 feet of the back.

Drilling is done with stopers. The holes are drilled close together and about 3-1/2 feet deep, so that only about a stick and a half or two sticks of powder is required to a hole. Great caution must be used in shooting, as heavy charges will loosen the walls and cause caving. The back of the stope is kept as level as possible, and generally the whole back is drilled before it is shot. As soon as drilling is completed, the stope is filled to within 3 or 4 feet of the back, leaving just enough room between the top of the fill and the back to permit loading the holes. A floor of 2-inch plank in 5-foot lengths is put down over the full length of the stope before blasting.

After shooting, the ore is shoveled by hand into the ore passes. Each length of plank flooring is taken up as soon as it is uncovered, to provide space for piling the waste that is sorted from the ore.

The ore ranges in width from 2 to 3 feet in the stopes. From 1-1/2 to 2 feet of waste is broken with the ore to permit a convenient working width of 4 to 5 feet. From 40 to 60 percent of the filling is from the overbreak in the stopes; the rest comes from development work. Mining and development work are balanced, so that the waste from development work can be used for filling in the stopes.

A very noticeable feature in all of the mining operations is the great precautions that are taken to prevent caving. It is the practice throughout the mine to drill short holes close together. Powder is used very sparingly, especially in the stopes. Loose ground in the walls or the backs of the stopes is stulled up before it gets a chance to move.

In drifting, a round of 10 to 12 holes is drilled in half a shift. About 2-1/2 sticks of powder are used in each hole to break a 4-foot round. Two men work in a drift heading; the mucker helps the machine man set up, tear down, load and shoot, cleans up any broken material that was left by the previous shift, and puts down temporary track and shoveling sheets. Shooting is done in the middle of the shift. The timbering and most of the mucking are done on the second half of the shift. The machine man does the timbering; permanent track is put down by a trackman. The drifts are kept timbered as close to the face as safe practice dictates, usually less than 50 feet.

Hoisting and Tramming

All tramming is done by hand. A cage in one compartment of the shaft is used for general hoisting. The other compartment is used for sinking. Very little waste is hoisted except when sinking the shaft or starting a new level. The main hoist has two drums, only one of which is used; it is operated by a 75-horsepower motor. The hoist for sinking is at the surface, and all material handled by it is hoisted to the surface, as facilities are lacking for transferring waste from the bucket to the levels so that it can be used for filling in the stopes.

Steel Sharpening and Timber Framing

Steel consumption is very low on account of the softness of the ground. One blacksmith and a helper take care of the steel sharpening and do all other blacksmith work. A carpenter and a helper frame all of the standard-size cribbing and drift sets and do any other incidental carpenter work about the plant. A power saw is used for most of the cutting.

Labor

The mine is operated three shifts a day. Miners are paid $4.00 a day, timbermen $4.50, and muckers $3.50. In November 1936 the mine payroll was as follows:

				Per day
Miners	22	@	$4.00	$88.00
Muckers	49	@	3.50	171.50
Timberman	2	@	4.50	9.00
Hoistmen	6	@	4.50	27.00
Top men and cagers	6	@	3.00	18.00
Total				313.50

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Quarters are furnished without charge, but a deduction of $1 a day is made for board. The boarding house is run by a company that operates a chain of camp hotels throughout the west.

Milling

Breaking and crushing.– The mill is at the shaft. Loaded cars from the cage are dumped by the top man onto an 8-inch grizzly that discharges into a coarse-ore bin of 100 tons capacity. The top man breaks up the material that is too large to go through the grizzly. Figure 17 is a flow sheet of the mill.

From the coarse-ore bin, the ore goes through a Wheeling Hollander No. 3 jaw crusher that crushes to about minus 3/4 inch, and thence into a fine-ore bin of 100 tons capacity.

Grinding.– The ore from the fine-ore bin is fed by a challenge feeder into a 6- by 6-foot ball mill using 3-inch balls. A Dorr duplex classifier is operated in closed circuit with the ball mill. The classifier overflow is 96 percent minus-65 mesh.

Flotation.– The classifier overflow goes to 12 mechanically agitated flotation cells. Finished concentrates are taken from 11 of the cells. The overflow from the last one is returned to the first cell.

Xanthate is added at the ball-mill intake, aerofloat at the classifier intake, and cresylic acid and coal-tar creosote (Barrett No. 4) at the head of the flotation circuit.

Thickening and filtering.– The concentrates go first to a thickener and then to a 3- by 4-foot and a 6- by 4-foot filter in parallel. The filtered concentrates are sacked by a filling machine. One man operates the filling machine, fastens the filled sacks, and places them where they are easily accessible for the hauling contractors.

Tailings disposal.– Tailings are not dewatered. The tailings pond is 4,300 feet from the mill and comprises about 5 acres of flat ground owned by the company. The dam is built up as necessity requires by two laborers who live at the pond. No water is reclaimed, either at the tailings pond or at the mill.

Metallurgy.– The following table shows gold and silver content in ounces per ton and the value of the heads, concentrates, and tails for the run of November 8, 1936, of 120 tons:

	Heads			Concentrates			Tails		
	Gold, ounces	Silver, ounces	value	Gold, ounces	Silver, ounces	value	Gold, ounces	Silver, ounces	value
Day	0.20	4.20	$9.63	1.60	31.20	$75.34	0.006	0.18	$0.33
Afternoon	.16	4.04	8.21	1.68	29.52	76.74	.005	.14	.27
Night	.16	4.63	8.63	1.52	32.88	73.94	.004	.16	.25

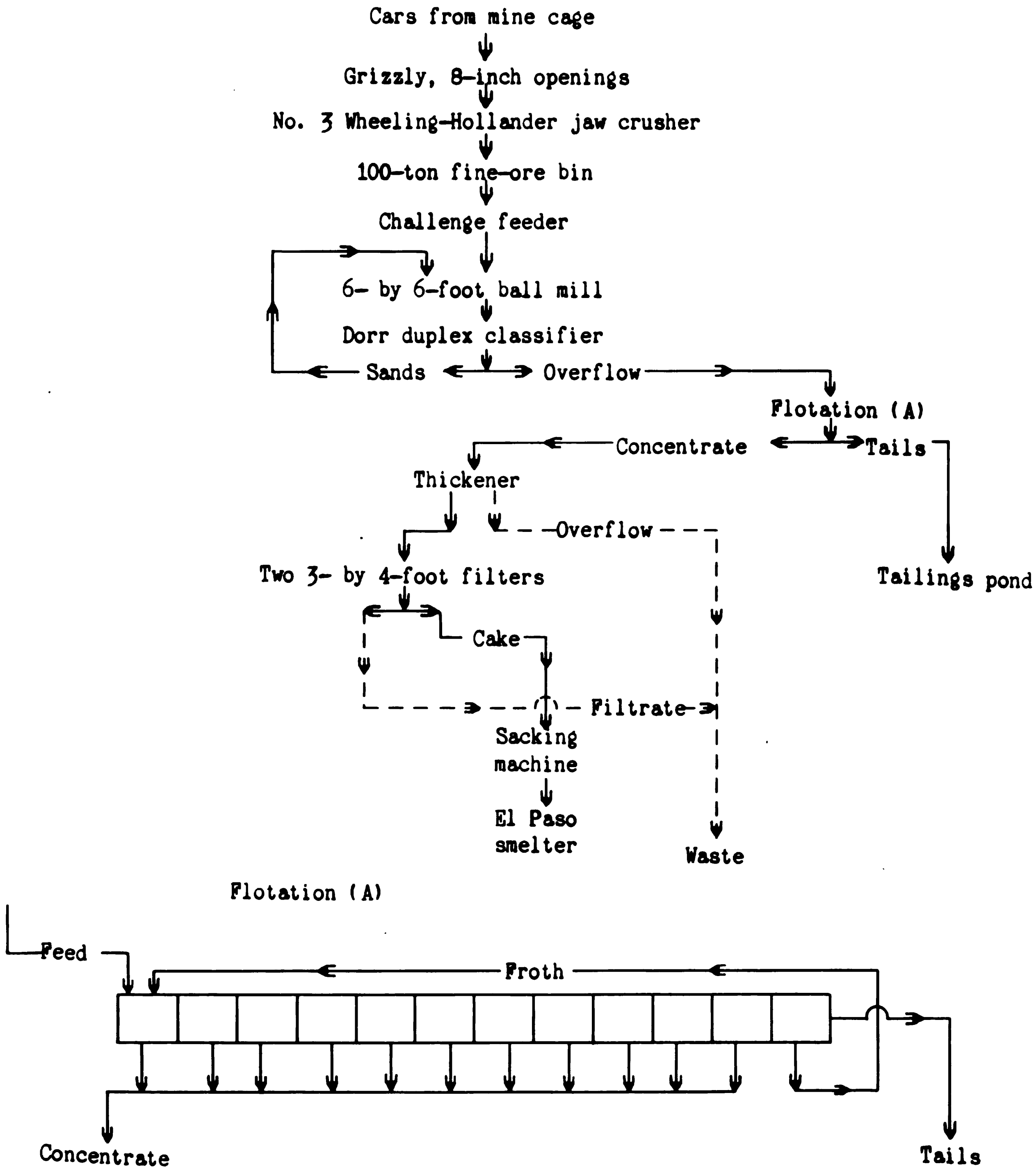

Figure 17.- Flow sheet, Hillside mine. (Capacity, 150 tons a day.)

Averages:

Heads	$8.83
Tails	.28
Concentrates	75.34
Recovery	97.2 percent
Ratio of concentration	8.78 to 1

Trucking, freight, and smelter.- After being sacked, the concentrates are trucked to the railroad station at Hillside, a distance of 32 miles. The hauling is done by contract for $2.50 a ton, which is also the rate for hauling material from Hillside to the mine. Combined freight and smelter rates from Hillside to the El Paso plant of the American Smelting and Refining Co. are $6 a ton. These rates are available to the company because of a special agreement entered into with the smelter. Payments for metals are as follows:

Gold	$32.8125	per ounce
Silver	.77	do.
Lead	.016	per pound
Copper	.007	do.

Labor.- The labor required to operate the mill, including tailings disposal is as follows:

Operators	1	@	$6.00	$6.00	
Do.	2	@	5.00	10.00	
Laborers	1	@	5.00	5.00	(sacking concentrates)
Do.	2	@	3.50	7.00	(tailings)
Total				28.00	

Power Plant

The power plant consists of a 6-cylinder Fairbanks-Morse Diesel engine of 420 horsepower direct-connected to a 355-kv-a. generator. Current is generated and distributed at 428 volts. The engine uses about 300 gallons of fuel oil at 7-1/2 cents per gallon per day. An auxiliary unit consisting of a 2-cylinder hot-head engine is connected to a 45-kw. generator with a V-belt drive.

A chief engineer and an assistant with three operators are required to run the power plant on a 3-shift basis.

The power house payroll is as follows:

Chief engineer	1	@	$7.00	$7.00
Cperators	3	@	4.00	12.00
Assistant engineer	1	@	4.50	4.50
Total				23.50

Comstock Dexter Mine

Situation

The Comstock Dexter mine is 32 miles northwest of the village of Hillside and 36 miles due west of Prescott in the canyon of Butte Creek, a tributary of Boulder Creek. The mine shaft is at an elevation of about 3,400 feet. The property consists of two patented and six unpatented claims, all of which belong to the Comstock Dexter Mines, Inc., F. M. Fitzgerald, president and general manager, Prescott, Ariz.

Topography and Geology

The country rock is granite and schist. The main vein, a fissure, is in the schist and bears about N. 5° W. and dips to the west at about 70°. The schistosity of the rock is approximately parallel to the vein in strike but dips about 70° in the opposite direction to the dip of the vein. The contact of the granite and the schist is about 300 feet east of the vein at the shaft. The distance varies at different places along the vein, but in general the vein and the granite schist contact are roughly parallel.

There is a dike of acid rock, probably monzonite or rhyolite, in the hanging wall of the main vein. It follows the vein as far as it has been developed throughout the mine. The vein filling is mostly quartz. In some places, however, the vein consists almost entirely of white gougy material, probably altered and decomposed dike rock. The principal ore-bearing minerals are the sulphides of lead, zinc, and iron. The iron sulphide is the most abundant, but lead and zinc sulphides are very common.

Several smaller veins parallel to the main vein have been opened by recent development work. In general, these veins are similar to the main vein, except that the dike rock in the hanging wall is not present. Assays from some of them indicate considerable amounts of commercial ore.

The mine has been surveyed and sampled by Edward L. Heff, mining engineer of Los Angeles. Estimates of ore reserves are based on ore that has been developed on two sides. No credit has been given for ore below the 356-foot level nor for ore on any other level that has not been opened on a level directly above or below. Estimates on this basis indicate an ore reserve of 40,000 to 50,000 tons with a value of $12 to $14 per ton.

History

The property was first located and worked by the Dillon brothers some time prior to 1890. The ore was treated in a small stamp mill, parts of whic still remain. Later, the property was acquired by John Lawler and associates It remained in the hands of the Lawler estate until 1932, when it was acquire by the General Minerals Corporation, which later on became the Comstock Dexter Mines, Inc.

The mine has not produced since 1893. The present owners did considerable development work, and built a road, camp, and power house. The property has been idle for about a year, except for pumping and camp maintenance.

Development

The mine is developed through a shaft 386 feet deep with levels at 152, 254, and 356 feet. Most of the work on the 152-foot level was done by former operators from a crosscut adit from the surface. A large amount of drifting but practically no mining was done from this level. Practically all mining that was done by the old timers was from another crosscut 30 feet above the 152-foot level and driven to the vein from another part of the canyon. The workings are badly caved and it was impossible to get any information as to what system of mining was used.

The present owners sunk the shaft from the surface, extended the drifts on the 152-foot level, and did from 300 to 500 feet of drifting on each of the two lower levels. Total development work, including the shaft, is from 2,000 to 2,500 feet.

The ground along the plane of the main vein is very heavy, and in many places the drifts require timbering. It is purposed to mine this ground by the horizontal cut-and-fill method, following, in a general way, the practices used at the Hillside mine. The ground along the other veins that have been opened appears to be more solid, and only a very small amount of timbering is required in the drifts. It is probably that this ground can be mined by the shrinkage method.

The mine makes about 40 gallons of water a minute, most of which is from the 356-foot level. A triplex plunger pump operated by a 20-horsepower motor lifts the water from the 356-foot to the 152-foot level, from which it runs by gravity to the portal of the crosscut adit.

Surface Equipment

Surface equipment consists of a power and compressor plant housed in a steel building, a single drum hoist operated by a 75-horsepower motor in a timber building, a blacksmith shop, and a timber head frame. The power plant consists of two generating units. Each unit consists of a 100-kw., 440-volt generator direct-connected to a 120-horsepower Diesel engine. The compressor plant consists of one compressor of 1,000-foot capacity operated by a 100-horsepower motor. The camp consists of boarding house and quarters for about 35 men, including a number of cottages for families and a refrigeration plant.

The water supply is obtained from a well about 1,500 feet south of the shaft. The water is pumped from the well and through a 3-inch pipe line to a storage tank at the boarding house. Water for drinking and ice making is pumped from a well east of the camp.

Arizona Homestake Mining Co.

Situation

The property of the Arizona Homestake Mining Co. is in the southern part of the Eureka district on the Santa Maria River and about 5 miles east of the Yuma County line. The property consists of two groups of claims - five unpatented claims on the north side of the river and the Homestake group of nine unpatented claims on the south side. The claims are owned by Alex Lucy and associates of Congress Junction and are operated under bond and lease by the Arizona Homestake Mining Co., M. T. Eastham of 425 California St., San Francisco, president, and R. A. Murry, of Congress Junction, vice president and manager.

The mine is reached by a road of questionable merit that turns north from the Congress Junction Kingman Highway about 20 miles west of Congress Junction. The distance to Congress Junction, the nearest railroad station and postoffice, is about 30 miles.

Topography and Geology

The elevation of the Santa Maria River at the mine is about 1,650 feet.

The country rock is granite and schist. There are two well-defined veins on Homestake group south of the river that are approximately parallel in strike, bearing about S. 30° W. The one nearest the river dips east at about 30°; the other one, which is about 300 feet farther southeast, dips to the east at from 55° or 60°. The vein on the Weepah group, north of the river, bears approximately north and south and dips about 80° to the east.

An assay map of these workings shows all shades of values in gold and silver from $1.50 to $47 a ton. The map indicates a considerable tonnage of $8 to $10 ore.

Water Supply

An adequate water supply was developed by sinking a shaft in the solid rock on the south bank of the river and crosscutting north from the bottom beneath the bed of the river. In this way the subsurface water of the stream bed is utilized and a constant supply is assured even when the surface of the stream bed becomes dry.

Development

The vein nearest the river on the Homestake group is developed by a shaft 200 feet deep on the dip of the vein, with 133 feet of drifting to the south and 166 feet of drifting to the north on the 200-foot level.

The other vein on the Homestake group is developed by a shaft 140 feet deep on the dip of the vein with levels at 50 and 100 feet from the collar.

On the 50-foot level there is 50 feet of drifting to the north and 10 feet to the south. On the 100-foot level there is 130 feet of drifting to the north and 60 feet to the south.

A shrinkage stope was started from the north drift of the 100-foot level; at one place it is about 35 feet high. It ranges in width from four to eight feet and the walls seem to hold well. In November 1936 the broken reserve in this stope was about 250 or 300 tons.

The vein on the Weepah group is developed by an adit drift about 20 feet above the river. From the end of this adit, there is a winze 60 feet deep on the dip of the vein. Higher up on the vein is a shaft about 75 feet deep, from which there is about 50 feet of drifting at about the 50-foot level.

Mining Equipment

The equipment at the shaft consists of an air hoist, a gasoline compressor of 310 cubic feet capacity, two ore buckets and a skip for sinking, and an ore bin of 35 tons capacity. During the winter of 1936, when the property was in production, the ore was hauled by a truck a distance of about 1/2 mile to the mill. The ore from the shaft on the upper Homestake group was hoisted in a skip that dumped from the top of the head frame directly into the mill bins. The hoist, power plant, and compressor are all housed in the same building.

Mill

The mill of 35 tons daily capacity was completed in the winter of 1935-36. It consisted of a dry 4- by 8-foot Hadsel mill for crushing and grinding the ore, and four flotation cells. The fine, dry product was taken from the discharge end of the Hadsel mill by means of a suction fan and mixed with the proper amount of water for flotation. When operations were first started, amalgam plates were used, but these were soon dispensed with.

The mill operated one shift a day from about the middle of March until about the middle of April 1936. During this time about 1,500 tons of ore were milled. Much of the material treated consisted of dump ore of rather low grade. From all of the material that was milled, $3,912 worth of concentrate and $237 worth of bullion were produced. The bullion was sold to the U. S. mint at San Francisco and the concentrates were shipped to the El Paso smelter. The cost of trucking the concentrates to Congress Junction was $4 a ton, and the freight from Congress Junction to El Paso was $10 a ton. The concentrates ran around $500 a ton.

The mill was destroyed by fire on July 25, 1936, and the property has been idle since.

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Oro Bueno Mine

Situation

The Oro Bueno mine is in the southern part of the Eureka district about 6 miles east of the Yuma County line and 1-1/2 miles north of the Santa Maria River. The property consists of three patented claims held under lease and option by the Oro Bueno Mining Co. of Phoenix. The mine is served by a road in passable condition that turns north from the Congress Junction Kingman highway about 20 miles west of Congress Junction. The distance to Congress Junction, the nearest railroad station and post office is 35 miles.

Topography and Geology

The country around the mine is very rugged. The elevation at the mine portal is about 2,000 feet.

The country rock is principally granite. The Oro Bueno vein strikes approximately north and south and dips to the west at about 45°. There is a schist belt that appears to be approximately parallel with the vein.

Water Supply

The water supply is from the Santa Maria River. The water is pumped through a 1-inch pipe line 8,300 feet long by a small gasoline-engine powered pump. The vertical lift is about 300 feet.

Development and Mining

The mine had been idle for many years when it was taken over by the present operators. The development, all of which was done by former operators, consists of two adit drifts, each about 500 feet long, connected by a raise.

Considerable stoping by the horizontal cut-and-fill method was done above the upper level. The chutes are from 20 to 25 feet apart and the ore passes are made of 2- by 12-inch plank. Waste that was broken with the ore was used as back fill. Stoping was started from the back of the drifts, and stulls and lagging were used to form the sill of the stope. Because of the dryness of the mine, most of the timbering is in a perfect state of preservation.

Up to November 1936 no mining had been done by the present operators. It was planned to carry out the general methods used by the old timers. Mounted drifters were to be used in drifts and crosscuts and stopers in the stopes and raises. All machines were equipped for 1-inch hexagon hollow steel. It had been planned to try both detachable and machine-sharpened bits and standardize on the type that gave the most satisfactory results. Ore was to be transferred from the upper level to the lower one through the raise connecting the two. All tramming from the lower level was to be by hand in ton cars. The waste dump and the ore bin are within a hundred feet of the portal of the lower level.

Milling

The mill was completed in November 1936 but was not put into operation until some time later. A trial run resulted in the breaking of the main gear of the ball mill which required considerable time to replace. Except for the flow sheet, which was subject to change, very few data were available.

Cyanidation was to be used entirely. All of the milling machinery was installed and ready for use but was not housed.

A Diesel engine of 40 horsepower and one of 60 horsepower were connected on the same line shaft with clutch couplings. The 40-horsepower engine was to be used for the compressor and the other one for the mill. The clutch couplings made it possible to use either engine for any unit. The ball mill, crusher, compressor, and several small pumps were belt-connected to the line shaft.

SUMMARY

The climate in the Wickenburg area is favorable for year-round operation. Pipe lines can be laid on the surface with little danger of freezing. Heating is unnecessary in mine and mill plants and inexpensive housing serves for most purposes. Highways are never closed by snow and only occasionally by washouts from summer freshets.

The Wickenburg area is in the arid belt and has no permanent running streams; water for milling purposes generally is relatively expensive. Water is available from springs and wells 50 to 100 feet deep in the foothills of the Weaver, Date Creek, and McCloud Mountains; operators in the Martinez, Weaver, and Eureka districts obtain their supply from these sources. Water is scarce in the Vulture and Big Horn districts. Some operators in these two districts obtain water from old mine workings; others have expended large sums on drilling wells and installing pipe lines.

The area, on the whole, is well served by automobile roads and railroads. Trucking rates are reasonable. Electric power is available in parts of the area; this power, however, is relatively expensive. Timber and other supplies are reasonable in cost.

The area is served by competitive smelters. Favorable marketing conditions of ores is an important feature of the area. Combined trucking, freight, and smelting charges on some low-grade ores near the shipping points are as low as $6.25 per ton. One producing company in the area does custom milling for other operators.

The characteristics of the ores in the area vary widely; they grade from completely oxidized siliceous material to heavy sulphides. Between the two extremes are ores consisting of various proportions of oxidized and sulphide ore minerals. The ores contain, on the whole, a high percentage of siliceous gangue. The ore at some of the mines responds readily to flotation; the

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cyanide process has been successful at a few properties. At a majority of operations, however, a combined flotation and cyanide process is required for a satisfactory extraction of the gold. This condition makes milling expensiv. Considering the favorable smelting and freight rates in the area, the small producer has an advantage in shipping to a custom milling plant only when, because of location, there is a saving in trucking charges.

Mining costs are relatively high throughout the area. The veins are relatively narrow and in most sections flat. At the Hillside mine the ground is heavy and requires close timbering and filling. At a number of small mines the shrinkage method could be practiced, but the demand for production to meet payrolls and intermittent operations have not been conducive to low costs. At the Octave mine, with modern equipment and excellent management, mining costs for 1935 and 1936 were $3.72 and $3.94, respectively, at a capacity of 70 to 80 tons per day. Many of the small producers are handicapped by the necessity of using equipment not best suited for their needs.

A number of mines not in production in November 1936 had favorable indications of becoming potential producers. Of these, the Alvarado gold min of the Weaver district and the Comstock Dexter mine of the Santa Maria district appear to be the most important. At the Alvarado property an extensive development program was bein completed, while the Comstock Dexter property had been developed extensively and was awaiting financing for a mill.

The author is of the opinion that one of the greatest potentialities of the area is in the production of crude siliceous ores for shipment to the smelters. Throughout the area are many small properties capable of producin 5 to 20 tons of shipping ore per day, as indicated by surface showings of ore. Expensive equipment is not needed to mine the flat veins. The small initial investment required for such operations should make the Wickenburg, Congress Junction, Aquila, and Hillside districts attractive to the prospect and small operator who lack capital to do extensive development work and to build mills.